Vol. 8, No. 12
June 30, 1983

Energy Research Abstracts

Abstracts 28789-31017

Technical Information Center
UNITED STATES DEPARTMENT OF ENERGY

CURRENT AWARENESS PUBLICATIONS ON ENERGY

To provide complete coverage of literature related to major Department programs, announcement publications that are comprehensive in their coverage of certain energy fields are issued regularly. All information in these publications, plus additional backup information, is included in the Energy Data Base of the Technical Information Center; all references are also available for machine searching via the on-line retrieval system, DOE/RECON, and the commercial on-line retrieval systems. Descriptions of these current awareness publications, which are supported either directly or indirectly by the DOE, appear below. Department of Energy components may receive the listed publications free from the Technical Information Center, P.O. Box 62, Oak Ridge, TN 37830. Telephone (615) 576-1303; (FTS) 626-1303.

PUBLICATIONS OF THE TECHNICAL INFORMATION CENTER

Energy Abstracts for Policy Analysis (EAPA)

A monthly abstract journal devoted to the analysis of energy research, conservation, and policy. Scope and coverage are limited to substantive articles or reports and emphasize the following: programmatic efforts; legislative, regulatory, and other legal aspects; social, economic, and environmental impacts; regional and sectoral analyses; institutional factors, etc. *EAPA* is available from the Superintendent of Documents, U. S. Government Printing Office, Washington, D. C. 20402; domestic subscribers $6.00, foreign $7.50 per copy; annual cumulative index, domestic $10.00, foreign $12.50 per copy. The annual subscription price is $70.00 for domestic subscribers and $87.50 for foreign subscribers.

Energy Research Abstracts (ERA)

A comprehensive semimonthly abstract journal devoted to all areas of energy-related information produced by the Department of Energy, other U. S. government organizations, and foreign governments. *ERA* is available to the public on a subscription basis from the Superintendent of Documents, U. S. Government Printing Office, Washington, D. C. 20402. The subscription rate for the 24 semimonthly issues is $165.00 for domestic subscribers and $206.25 for foreign subscribers. A single issue costs $9.50 (domestic) or $11.90 (foreign).

The following publications are available to the public on a subscription basis from the National Technical Information Service (NTIS), Springfield, Virginia 22161. The annual subscription rate for one volume (calendar) year (12 issues plus cumulative index) is $75.00 for domestic subscribers and $150.00 for subscribers outside the North American continent, except as listed below for *DOE Patents Available for Licensing (PAL)*. A single issue is $7.00 (domestic) and $14.00 (outside the North American continent).

Current Energy Patents (CEP)

A monthly publication providing abstracting and indexing coverage of the international patent literature, including patent applications, that concerns any aspect of energy production, conservation, and utilization. Available as PB83-902800.

DOE Patents Available for Licensing (PAL)

DOE is prepared to grant exclusive or nonexclusive, revocable licenses under DOE-owned U. S. patents and patent applications; this semiannual publication provides abstracting and indexing coverage to this literature. Available as PB83-946800; the annual subscription price is $14.00 (domestic) and $28.00 (foreign).

Energy and the Environment (EAE)

A monthly abstract journal devoted to information on the impacts of energy-related activities and radioactive and nonradioactive pollutants on the environment. Available as PB83-914900.

Fossil Energy Update (FEU)

A monthly abstract journal devoted to information on the processing and use of fossil fuels. Available as PB83-914600.

Fusion Energy Update (CFU)

A monthly abstract journal devoted to information on controlled thermonuclear research. Available as PB83-915300.

Solar Energy Update (SEU)

A monthly abstract journal devoted to information on the utilization of solar energy, including biomass and tidal and wind power. Available as PB83-914500.

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Geothermal Energy Technology (GET)

A semimonthly current awareness bulletin devoted to information on the exploration and development of geothermal resources. Available as PB83-914700.

Nuclear Fuel Cycle (NFC)

A semimonthly current awareness bulletin covering all aspects of the nuclear fuel cycle, both front end and back end. Available as PB83-913400.

Nuclear Reactor Safety (NRS)

A semimonthly current awareness bulletin covering the following safety aspects: accident analysis, safety systems, radiation protection, decommissioning and dismantling, and security measures. Available as PB83-913500.

Radioactive Waste Management (RWM)

A semimonthly current awareness bulletin covering the following management aspects: transport and storage, waste processing, waste disposal, waste storage, radioactive effluents, and shipping containers. Available as PB83-902900.

INTERNATIONAL ENERGY PUBLICATIONS

The Technical Information Center cooperates with the following organizations in the publication of international abstract journals: (1) International Atomic Energy Agency, International Nuclear Information System, Vienna, Austria, for *Atomindex;* (2) International Energy Agency, IEA Coal Research, London, England, for *Coal Abstracts;* and (3) International Energy Agency, Biomass Conversion Technical Information Service, Dublin, Ireland, for *Biomass Abstracts*. In each case, the cognizant foreign agency provides the non-U.S. information to TIC for inclusion in the Energy Data Base; in turn, TIC provides the U.S. information for input into the respective journal.

Atomindex

A semimonthly abstract journal providing worldwide coverage of information on nuclear science and technology. *Atomindex* is available by subscription from UNIPUB, 345 Park Avenue South, New York, NY 10010. The cost of an annual subscription, 24 semimonthly issues and semiannual and annual cumulative indexes, is $290.

Biomass Abstracts

A bimonthly abstract journal with comprehensive coverage of information in any step involved in the eventual conversion of biomass to energy. *Biomass Abstracts* is available free to Department of Energy components and contractors from the Technical Information Center. Non-DOE organizations may obtain *Biomass Abstracts* from Biomass Conversion Technical Information Service, Institute for Industrial Research and Standards, Ballymun Road, Dublin 9, Ireland, for 42 IR pounds per year. Make checks payable to the Institute.

Coal Abstracts

A monthly abstract journal providing comprehensive worldwide coverage of information in the field of coal science and technology. *Coal Abstracts* is available to Department of Energy components and contractors from the Technical Information Center. Non-DOE organizations may obtain *Coal Abstracts* from IEA Coal Research, Technical Information Service, 14-15 Lower Grosvenor Place, London SW1W 0EX, England, for 100 pounds sterling per year.

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ENERGY RESEARCH ABSTRACTS

ABOUT THE TECHNICAL INFORMATION CENTER

The Technical Information Center in Oak Ridge, Tennessee, has been the national center for scientific and technical information for the Department of Energy (DOE) and its predecessor agencies since 1946. In developing and managing DOE's technical information program, the Center places under bibliographic control not only DOE-originated information but also worldwide literature on scientific and technical advances in the energy field and announces the source and availability of this information. Whereas the literature of science is emphasized, coverage is extended to DOE programmatic, socioeconomic, environmental, legislative/regulatory, energy analysis, and policy-related areas. To accomplish this mission, the Center builds and maintains computerized energy-information data bases and disseminates this information via computerized retrieval systems and announcement publications such as abstracting journals, bibliographies, and update journals. Direct access to the Center's most comprehensive data base, the Energy Data Base, is available to the public through commercial on-line bibliographic retrieval systems. The Energy Data Base and many of the Center's energy-related data bases are available to DOE offices and contractors and to other government agencies via DOE/RECON, the Department's on-line information retrieval system. The Center has developed and maintains systems to record and communicate energy-related research-in-progress information, to maintain a register of DOE public communications publications, to track research report deliverables from DOE contractors, and to test and make available DOE-funded computer software programs with scientific and management applications. The Center also maintains a full-scale publishing capability to serve special publication needs of the Department. To effectively manage DOE's technical information resources, the Center's program is one of continual development and evaluation of new information products, systems, and technologies.

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Energy Research Abstracts (ERA) provides abstracting and indexing coverage of all scientific and technical reports, journal articles, conference papers and proceedings, books, patents, theses, and monographs originated by the U. S. Department of Energy, its laboratories, energy centers and contractors. *ERA* also covers other energy information prepared *in report form* by federal and state government organizations, foreign governments, and domestic and foreign universities and research organizations. The user should remain aware that *ERA* coverage of non-report literature is limited to that generated by Department of Energy activity.

ERA is comprehensive in its subject scope, encompassing the DOE's research, development, demonstration, and technological programs resulting from its broad charter for energy sources, supplies, safety, environmental impacts, and regulation.

ERA is available on an exchange basis to universities, research institutions, industrial firms, and publishers of scientific information. Inquiries should be directed to the Technical Information Center, P. O. Box 62, Oak Ridge, Tennessee 37830.

ERA is available to the public on a subscription basis from the Superintendent of Documents, U. S. Government Printing Office, Washington, D. C. 20402. The subscription rate for the 24 semimonthly issues is $165.00 for domestic subscribers and $206.25 for foreign subscribers. A single issue costs $9.50 (domestic) or $11.90 (foreign). The cumulative indexes will be available in printed form from the Superintendent of Documents, U. S. Government Printing Office, Washington, D. C. 20402, and in microfiche form from the National Technical Information Service, U. S. Department of Commerce, Springfield, Virginia 22161, and from Engineered Systems, P. O. Box 866, Oak Ridge, Tennessee 37830.

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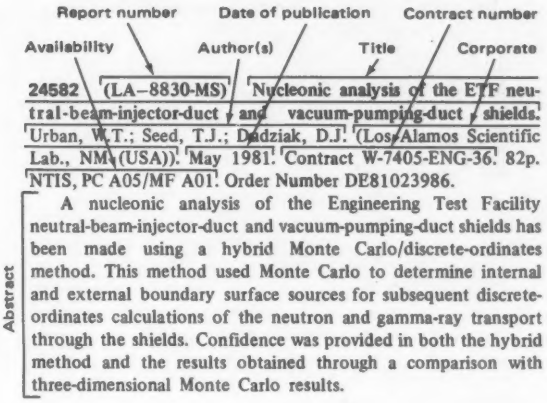
HOW TO USE *ENERGY RESEARCH ABSTRACTS*

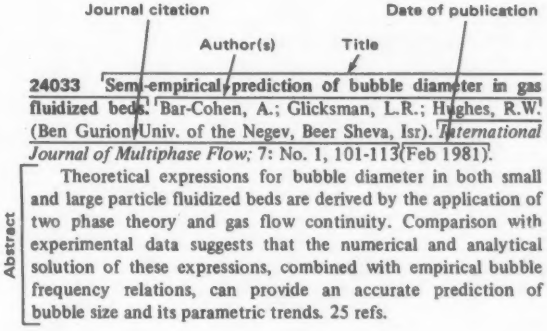
ABSTRACTS IN *ENERGY RESEARCH ABSTRACTS*

The principal elements of abstract entries for a typical research and development report and a typical technical journal article are illustrated below.



24582 (LA–8830-MS) Nucleonic analysis of the ETF neutral-beam-injector-duct and vacuum-pumping-duct shields. Urban, W.T.; Seed, T.J.; Dudziak, D.J. (Los Alamos Scientific Lab., NM (USA)). May 1981. Contract W-7405-ENG-36. 82p. NTIS, PC A05/MF A01. Order Number DE81023986.

A nucleonic analysis of the Engineering Test Facility neutral-beam-injector-duct and vacuum-pumping-duct shields has been made using a hybrid Monte Carlo/discrete-ordinates method. This method used Monte Carlo to determine internal and external boundary surface sources for subsequent discrete-ordinates calculations of the neutron and gamma-ray transport through the shields. Confidence was provided in both the hybrid method and the results obtained through a comparison with three-dimensional Monte Carlo results.



24033 Semi-empirical prediction of bubble diameter in gas fluidized beds. Bar-Cohen, A.; Glicksman, L.R.; Hughes, R.W. (Ben Gurion Univ. of the Negev, Beer Sheva, Isr.). *International Journal of Multiphase Flow*; 7: No. 1, 101-113 (Feb 1981).

Theoretical expressions for bubble diameter in both small and large particle fluidized beds are derived by the application of two phase theory and gas flow continuity. Comparison with experimental data suggests that the numerical and analytical solution of these expressions, combined with empirical bubble frequency relations, can provide an accurate prediction of bubble size and its parametric trends. 25 refs.

INDEXES TO *ENERGY RESEARCH ABSTRACTS*

Five indexes are provided for approaching the contents of each issue of *Energy Research Abstracts (ERA)*. Each index is preceded by an introduction that details the organization of the index and the principles by which it was compiled. The reader is referred to these introductions for information not found in the index examples that follow.

• Corporate Author Index

Technical report literature is indexed using the name of the organization or institution responsible for the issuance of the report.

24582 (LA–8830-MS) Nucleonic analysis of the ETF neutral-beam-injector-duct and vacuum-pumping-duct shields. Urban, W.T.; Seed, T.J.; Dudziak, D.J. **(Los Alamos Scientific Lab., NM (USA)).** May 1981. Contract W-7405-ENG-36. 82p. NTIS, PC A05/MF A01. Order Number DE81023986.

is indexed as:

Los Alamos Scientific Lab., NM (USA)
Nucleonic analysis of the ETF neutral-beam-injector-duct and vacuum-pumping-duct shields, 6:24582 (R:US)

• Personal Author Index

Each author's name is indexed in the form appearing on the document abstracted, with the exception that given names are reduced to initials:

Bar-Cohen, A., Semi-empirical prediction of bubble diameter in gas fluidized beds, 7:24033 (J:US)
Dudziak, D.J., *See* Urban, W.T., 6:24582
Glicksman, L.R., *See* Bar-Cohen, A., 7:24033
Hughes, R.W., *See* Bar-Cohen, A., 7:24033
Seed, T.J., *See* Urban, W.T., 6:24582
Urban, W.T., Nucleonic analysis of the ETF neutral-beam-injector-duct and vacuum-pumping-duct shields, 6:24582 (R:US)

• Subject Index

The subject index consisting of entries naming specific materials, objects, and processes is arranged alphabetically. Document titles, informative phrases, or both specific to these entries are arranged alphabetically under the entries.

TOKAMAK ETF
Neutral Atom Beam Injection
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• Contract Number Index

DOE technical literature is indexed using contract numbers under which the literature was produced. This index contains the contract number with corresponding abstract and report numbers.

W-7405-ENG-36	**Los Alamos National Lab., NM (USA)**	
	6:24582	LA–8830-MS

• Report Number Index

Technical report literature is also indexed using report numbers. This index includes information on where individual reports may be obtained. Patents and conference papers are indexed here as a matter of convenience. When a report is supplied under an Order Number, that number is included in the availability statement. An Order Number–Report Number Correlation is included for convenience.

LA–		
8830-MS	**6:24582**	**NTIS, PC A05/MF A01. Order Number DE81023986, Distribution Category STD-20d**

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SUBJECT CONTENTS (NUMERICAL LISTING)

Six-digit subject category numbers are used in the storage, retrieval, and manipulation of bibliographic information entered into DOE's computerized bibliographic information system. The six-digit category numbers are utilized as if they were three pairs of two-digit numbers, the first two pairs being used to arrange the abstract content of *Energy Research Abstracts*. The following listing includes the totality of the 40 first-level and 294 second-level subject categories used. Because each issue of *ERA* announces only those documents becoming available during a semimonthly period, some subject categories may not be represented in every issue. The complete subject category scheme with scope notes is available as DOE/TIC-4584-R4 from NTIS for $7.00.

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SUBJECT CONTENTS (ALPHABETICAL LISTING)

Six-digit subject category numbers are used in the storage, retrieval, and manipulation of bibliographic information entered into DOE's computerized bibliographic information system. The six-digit category numbers are utilized as if they were three pairs of two-digit numbers, the first two pairs being used to arrange the abstract content of *Energy Research Abstracts*. The following listing includes the totality of the 40 first-level and 294 second-level subject categories used. Because each issue of *ERA* announces only those documents becoming available during a semimonthly period, some subject categories may not be represented in every issue. The complete subject category scheme with scope notes is available as DOE/TIC-4584-R4 from NTIS for $7.00.

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ENERGY RESEARCH ABSTRACTS

01 COAL AND COAL PRODUCTS

28789 (CONF-820273—, pp 13p, Paper 4) **University of Alaska coal research project.** Beistline, E.H.; Rao, P.D. (Univ. of Alaska, Fairbanks). 1982. Resource Development Council for Alaska, 444 West 7th Ave., Box 516, Anchorage, AK $30.00.

From 2. Alaska coal marketing conference; Anchorage, AK, USA (18 Feb 1982).

The objectives of the University of Alaska coal laboratory are: to characterize major coal seams for planning for mining and utilization of Alaska's coal resources (this includes proximate analysis, ultimate analysis, ash characterization, reflectance analysis (for rank determination as well as for coking and coal conversion potential analysis), and petrological analysis (coking and conversion)); to conduct washability studies to determine beneficiation potential; to conduct drying studies to improve heating value of low rank coals; to conduct basic studies in coal petrology so as to understand the origin and characteristics of coal macerals (petrographic components); to prepare high grade (low ash, low moisture) coal pellets or briquets for domestic use; to study feasibility of transportation of coals from remote coal fields to deepwater ports; to study palynological, petrological and mineralogical studies of coal basins to better understand the environments of coal deposition; to do liquefaction research on Alaska's coals; to design mining system for steeply dipping seams taking into consideration Alaska's arctic, sub-arctic, and permafrost conditions; and to make studies leading to the development of small mines for Alaska's villages.

0104 Processing

REFER ALSO TO CITATION(S) 28822, 28822, 28827, 28829, 28830, 28831, 28832, 28833, 28865, 28875, 28911, 28979, 29287, 29288, 29780, 30313

28790 (CONF-820273—, pp 6p, Paper 22) **Coal: the fuel of the future.** Gray, M.D. (NCB Ltd., Harrow, Middlesex, England). 1982. Resource Development Council for Alaska, 444 West 7th Ave., Box 516, Anchorage, AK $30.00.

From 2. Alaska coal marketing conference; Anchorage, AK, USA (18 Feb 1982).

Various methods of gasifying and liquefying coal are described briefly and compared. Combined-cycle power plants are also considered briefly. (LTN)

28791 **(DOE/CH/00016—1367) Calcium silicate cement sorbent for H_2S removal and improved gasification processes. Annual progress report, October 1, 1981-September 30, 1982.** Yoo, H.J.; Steinberg, M. (Brookhaven National Lab., Upton, NY (USA)). Oct 1982. Contract AC02-76CH00016. 38p. NTIS, PC A03/MF A01. Order Number DE83009577.

Commercial calcium silicate bearing Portland cement type III (PC III), in the form of agglomerated cement sorbent (ACS) pellets, is being investigated for in-situ desulfurization of fuel gases and for improved coal gasification. The preparation procedure and conditions for pelletizing agglomerated cement sorbent (ACS) by a low energy, low cost agglomeration technique have been modified using a two-stage pelletization procedure, which yields ACS pellets of greater mechanical strength. A 40 mm ID bench scale fluidized bed gasifier (FBG) was used to determine sulfur removal efficiency of ACS pellets as well as their attrition resistance, using a simulated gas mixture. These tests show that 90% or more of the sulfur removal from the gas is achieved until 35% of the ACS pellet is sulfidated and that it has excellent attrition resistance (less than 0.1% wt loss) during cyclic tests excluding the first conditioning cycle. The gasification of coal by partial oxidation with air to low Btu gas was conducted in a 1-inch bench scale FBG unit by our collaborator, the Foster Wheeler Corporation (FWC). At temperatures between 800°C and 950°C the efficiency of coal gasification is improved by as much as 40% when ACS pellets are used compared to the use of Greer limestone. At the same time the sulfur removal efficiency is increased from 50 to 65% with Greer limestone to over 95% with the ACS pellets. The test on sulfur fixation characteristics of the sorbent in the 1-inch FBG unit using a simulated gas also shows that the ACS pellet is much more reactive toward H_2S than Greer limestone. The ability of ACS pellets to simultaneously desulfurize and improve the gasification efficiency of coal in FBG justifies further investigation.

28792 **(DOE/ER/10673—T1) Metallocarboranes structurally engineered for the reduction of carbon monoxide.** Hawthorne, M.F. (California Univ., Los Angeles (USA). Dept. of Chemistry). 1982. Contract AT03-80ER10673. 21p. NTIS, PC A02/MF A01. Order Number DE83010619.

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The research conducted in this initial period has involved the development and evaluation of various metallacarborane complexes as homogeneous catalysts for the transformation of carbon monoxide into useful chemical feedstocks. The discussions presented herein summarize our preliminary results in several areas of primary interest: (1) the evaluation of the activity of certain rhoda- and ruthenacarborane complexes as catalyst precursors for the water gas shift reaction; (2) the synthesis of heterobimetallic metallacarboranes which possess both early and late transition metal vertices, as well as those which contain main group elements such as aluminium and gallium, for the study of metal-metal cooperativity in the reduction of carbon monoxide; and (3) the preparation and screening of a series of rhodacarborane complexes as hydroformylation catalysts. We believe that the use of these species as catalysts precursors should offer distinct synthetic and practical advantages over simple metal carbonyl complexes in the catalytic reduction of CO. The ease of derivatization of the carboranyl moiety utilized in the synthesis of potential catalysts has provided a virtually unparalleled capability for molecular design. The catalyst precursors used in these studies have been shown to exhibit several novel structural features which include a structurally sensitive closo/exo-nido tautomerism, which appears to be a key feature in the ability of these species activate small molecules such as dihydrogen. While practical hydroformylation, water gas shift, and methanation catalysts based upon metallacarborane species have yet to be developed, many stoichiometric reactions important catalytic schemes have been observed, and rational methods for the modification of the chemical reactivity of existing compounds have been developed.

28793 **(DOE/ER/10673—T2) Metallocarboranes structurally engineered for the reduction of carbon monoxide.** Hawthorne, M.F. (California Univ., Los Angeles (USA). Dept. of Chemistry). 1982. Contract AT03-80ER10673. 13p. NTIS, PC A02/MF A01. Order Number DE83010038.

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The research performed under the auspices of the above Department of Energy grant has been primarily concerned with the preparation of rhoda- and ruthenacarborane complexes as possible catalysts for the water gas shift reaction. Water gas shift activity has been demonstrated for the rhodacarborane complex closo-3-(PPh_3)-3-(CO)-4-(C_5H_5N)-3,1,2-$RhC_2B_9H_{11}$. Ongoing work concerning this complex involves modification to improve activity by the use of more basic phosphine ligands. Studies involving ruthenacarboranes are based upon the 3,1,2- and 2-1,7-isomers of $Ru(PPh_3)_2(CO)C_2B_9H_{11}$ and the complex closo-3,3,3-$(CO)_3$-3,1,2-$RuC_2B_9H_{11}$. The latter complex reacts rapidly with tetra(n-butyl)ammonium hydroxide in ether to yield a white crystalline compound formulated as an anionic metallocarboxylic acid $[Ru(CO)_3(COOH)C_2B_9$

$H_{11}][N(n\text{-butyl})_4]$. As such complexes have been observed as intermediates in the conversion of carbonyl species to hydrido anions, work is continuing on the conversion of this species to the biscarbonylhydridoruthenacarborane anion and completion of the catalytic cycle. 7 figures.

28794 **(DOE/ET/10324—T16) Technical and economic assessment of the IGT peat-gasification process. Engineering support services for the DOE/GRI Coal Gasification Research Program.** Bostwick, L.E.; Hubbard, D.A.; Laramore, R.W.; Senules, E.A.; Shah, K.V. (Kellogg (M.W.) Co., Houston, TX (USA)). Apr 1981. Contract AC01-78ET10324. 71p. (FE—2778-48). NTIS, PC A04/MF A01. Order Number DE83011006.

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Kellogg has completed a moderately detailed design and cost estimate of a 250 billion Btu/Day grass-roots SNG plant using the Peatgas process. Results indicate that the cost of SNG would be $4.40/MM Btu, using a cost of $1.50/MM Btu for peat feedstock at 50% moisture. The SNG cost is reasonably competitive with that currently estimated for SNG from coal, and Kellogg would anticipate that capital cost reductions, via design optimization, could reduce the NSG cost to a level which is quite competitive. The cost of peat feedstock is a critical area of concern in evaluating economics of the Peatgas process. The value chosen for the base-case economics ($1.50/MM Btu) is in the higher portion of the price range considered typical by most investigators; the price of $1.50/MM Btu was chosen arbitrarily to represent a 50% increase over the cost of coal ($1.00/MM Btu) used by Kellogg in parallel studies, to reflect higher costs for land use and reclamation and for harvesting and dewatering of peat. In a study concurrent with that reported here, Kellogg found that one method of wet harvesting and mechanical/thermal dewatering yields a peat (50% moisture) cost which is unfavorably high and was therefore rejected for use as a base-case cost since much cheaper feedstock is apparently available by other harvesting/dewatering methods. The base-case cost of SNG is moderate somewhat by the values placed on the benzene and oil coproducts (i.e., $1.10 and $0.75 per gallon, respectively). The total of such credits amounts to about 39% of the gross operating cost; a reduction in value of the coproducts would adversely affect the cost of SNG. Certain technical factors are discussed: materials handling problems, high reactivity, low sulfur content, and limited gasification data.

28795 **(DOE/ET/10324—T45) Engineering-support services for the DOE/GRI Coal-Gasification Research Program. Quarterly technical progress report, July-September 1980.** Bostwick, L.E.; Brancheau, R.J.; Castiglioni, B.P. (Kellogg (M.W.) Co., Houston, TX (USA)). Jan 1982. Contract AC01-78ET10324. 37p. (FE—2778-32). NTIS, PC A03/MF A01. Order Number DE83011005.

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Kellogg activities included contained monitoring of test operations at the Hygas, BI-GAS, Westinghoue, Exxon and Bell plant sites. Peat gasification laboratory tests were also monitored; Rockwell testing ended during June. Pilot Plant/PDU test runs monitored and reported were: Hygas Test 87 (the last of the pilot plant series), BI-GAS Tests G-13 and G-14, Westinghouse test runs TP-027, TP-027-4 and TP-027-5, Exxon test periods 19 through 21 and Bell Tests 2174 through 3195. Kellogg continued its work on the Hygas data base evaluation and began an evaluation of the scaleup risks of the Westinghouse oxygen-blown gasifier. Work under new task orders was initiated. The topics included are: Technical/Economic Assessments of Westinghouse, Exxon and Peatgas, Gasifier Vessel Design, Technical/Economic Comparisons of Westinghouse and U-Gas, Peat Harvesting and Dewatering, and Carbonyl Formation in Coal Gasification processes. Economics are essentially complete for the Screening Evaluations of Westinghouse, Exxon and Rockwell and report preparation has begun. Work on the Pilot/Plant FDU Safety Evaluation Task continued.

28796 **(DOE/ET/10324—T48) Engineering support services for the DOE/GRI Coal Gasification Research Program. Quarterly technical progress report for the period October-December 1979.** Bostwick, L.E.; Brancheau, R.J.; Castiglioni, B.P.; Gunderson, J.M.; Hare, R.M.; Hubbard, D.A.; Jacks, J.P.G.; Smith, M.R.; Starr, D.W. (Kellogg (M.W.) Co., Houston, TX (USA)). Dec 1981. Contract AC01-78ET10324. 42p. (FE—2778-20). NTIS, PC A03/MF A01. Order Number DE83011008.

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Kellogg activities included the continued monitoring of test operations at the Hygas, BI-GAS, Westinghouse, Exxon and Rockwell plant sites. Test runs monitored and reported were: Hygas tests 83 and 84, BI-GAS tests G-9, G-10 and G10A, Westinghouse tests TP-025-2 and TP-023-3, Exxon test periods 3 through 6 and Rockwell tests 318-024 through 318-043. Kellogg initiated monitoring of the test program at Bell Aerospace. Bench-scale test activities for the IGT Peatgas program were monitored. Kellogg continued their participation in Metals Properties Council activities. The final report on DOE Task No. 3, Consultation on Westinghouse PDU, was completed and issued. The report on Task No. 6, Westinghouse Risk analysis, is complete and in the final review stage. Work continued on the PDU Screening Evaluation, Rockwell and Exxon processes: process work is essentially complete and cost estimation assurance study is in various stages of completion for each of the processes being monitored. Further information on the safety-related aspects of the processes is still being received and evaluated.

28797 **(DOE/ET/14705—1394-Vol.1) BI-GAS coal-gasification program. Final report, November 1979-August 1982.** McIntosh, M.J. (Stearns-Roger Corp., Denver, CO (USA)). 31 Jan 1983. Contract AC21-80ET14705. 131p. NTIS, PC A07/MF A01. Order Number DE83008410.

The primary purpose of this report is to cover in detail activities at the BI-GAS Coal-Gasification Pilot Plant from November 1979 through August 1982. During this period Stearns-Roger Incorporated was the prime contractor for the project. Progress included improvements in the reliability of coal and char feeding systems, maintenance of slag tapping, durability of the char burners and removal of supplemental fuel gas. (Operations had previously been conducted using supplemental gas feed to insure a reducing atmosphere in the gasifier.) Durations of test runs using Montana Rosbud coal were increased, in some cases to over 150 hours without serious equipment problems. The process and equipment modifications which led to these improvements are discussed in the report.. In addition, summaries of each gasifier test, major plant modifications and conclusions and recommendations are included. Volume 2 contains topical reports which describe the operation of the gasifier and each of the auxiliary process areas as well as heat and material balance data, computer simulation, gasification of Pittsburgh seam coal and materials evaluation.

28798 **(DOE/ET/14705—1394-Vol.2) BI-GAS coal-gasification program. Final report, November 1979-August 1982.** McIntosh, M.J. (Stearns-Roger Corp., Denver, CO (USA)). 31 Jan 1983. Contract AC21-80ET14705. 332p. NTIS, PC A15/MF A01. Order Number DE83008370.

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The primary purpose of this report is to cover in detail activities at the BI-GAS Coal-Gasification Pilot Plant from November 1979 through August 1982. During this period Stearns-Roger Incorporated was the prime contractor for the project. Volume 2 contains topical reports which describe the operation of the gasifier and each of the auxiliary process areas as well as heat and material balance data, computer simulation, gasification of Pittsburgh seam coal and materials evaluation.

28799 **(DOE/ET/14842—T20) Coal-slurry pump development. Technical progress report No. 42.** Wong, G.S. (Rockwell International Corp., Canoga Park, CA (USA). Rocketdyne Div.). 15 Apr 1983. Contract AC03-79ET14842. 10p. NTIS, PC A02/MF A01. Order Number DE83010204.

The Coal-Slurry Pump Development Program was initiated in October 1979 and planned for completion in December 1982. A proposal has been submitted to extend the end date to 30 June 1983 and the program is continuing with the revised schedule. In the first phase an experimental prototype of a two-stage, high pressure, centrifugal slurry pump was fabricated and assembled into a test unit. In the second phase the experimental pump was delivered to the Colorado School of Mines Research Institute test facility for initial testing in hot oil and subsequent testing in a coal-oil slurry environment. Rocketdyne will supply technical support and coordination on test facility interface requirements and for testing of the experimental pump to evaluate hydraulic, mechanical, material and operational performance characteristics. Because of the recent significant activities accomplished, this monthly report will cover the period up to 12 April 1983.

28800 **(DOE/FE/05120—T6) Design and development of a high-velocity wedge separator for particle removal in coal-gasification plants. Quarterly report, October 1-December 31, 1982 and technical progress and Phase IV report.** Linhardt, H.D.; Boone, C.G.; Beveridge, J.H. (Linhardt and Associates, Inc., Newport Beach, CA (USA)). 31 Jan 1983. Contract AC01-81FE05120. 84p. NTIS, PC A05/MF A01. Order Number DE83010248.

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The HTPS array consisting of nine (9) modules, (54 elements), was successfully tested in the Westinghouse TDC facility. Reliable operation has been demonstrated for thirty six (36) hours duration at specified test conditions. While some data scatter could not be avoided within the available test period, the overall result is encouraging and significant. The module testing at the L and A HTPS test facility provided consistent performance data with high degree of accuracy. Collection efficiencies as high as 97.5% for 250 psia and 1000°F have been demonstrated for the particle size range $> 2\ \mu$. Figure 3-1 compares the collection efficiencies as function of particle sizes in the range $0.2\ \mu >$ of known cyclone configurations applicable to hot gas cleanup to the particle size performance of the L and A HTPS. The performance advantage of the HTPS is significant. Future work is recommended in order to demonstrate reliable operation of the HPTS at elevated temperatures up to 1650°F. Resistance to plugging needs to be investigated at higher temperatures and pressures, and reliability has to be established by a cost effective endurance test program.

28801 **(DOE/MC/14386—1377) Low-energy process for separating hydrogen and methane in advanced coal-gasification processes. Final report, September 8, 1980-January 7, 1983.** Yang, R.T.; Saunders, J.T.; Byers, S.G.; Wang, S.S. (State Univ. of New York, Buffalo (USA). Dept. of Chemical Engineering). 1983. Contract AC21-80MC14386. 195p. NTIS, PC A09/MF A01. Order Number DE83009661.

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This report contains the detailed results of the following three-part study: Part I. Adsorption of H_2/CH_4 from single and mixed gases on activated carbon, coals and chars; Part II. Adsorption of H_2S and its mixtures with H_2/CH_4 on activated carbon, coals and chars; and Part III. Separation of H_2/CH_4 and $H_2/CH_4/H_2S$ mixtures by a temperature-cycling process. The original scope of the study, as indicated by the title of the report, has been expanded to include H_2S in the gas mixture. The inclusion of H_2S was to study the feasibility of combining the H_2/CH_4 separation step with the H_2S removal step into a single process. The success of the feasibility study naturally leads to the possibility of separating both CO_2 and H_2S from H_2 and CH_4 in coal gasification products by the cyclic adsorption/desorption process. The results of the study are presented.

28802 **(DOE/MC/14399—T5) CNG acid-gas-removal process. Technical progress report No. 6, 1 February 1982-30 April 1982.** Auyang, L.; Brown, W.R.; Cook, W.J.; Liu, Y.C.; Petrik, M. (Helipump Corp., Cleveland, OH (USA)). Mar 1983. 40p. NTIS, PC A03/MF A01. Order Number DE83010265.

Three tasks were active during the sixth quarter: design and construction of a bench scale triple-point crystallizer; slurry pumping; and water removal. Final designs and equipment specifications for the crystallizer control and data acquisition systems are presented. Slurry pumping is complete. The minimum net positive suction head to successfully pump slurries of solid carbon dioxide in an organic liquid carrier solvent have been determined for two gear pumps, a positive displacement pump, and a centrifugal pump. All are about five feet. Solids concentration ranged from 5 to 25% solid carbon dioxide by weight. For the task of water removal, the solubility of water in liquid carbon dioxide has been determined. The solubility ranges from about 370 ppM water in liquid carbon dioxide at -27°C to about 150 ppM at -55°C.

28803 **(DOE/METC/SP—193) Lockhopper valve testing and development program.** (Department of Energy, Morgantown, WV (USA). Morgantown Energy Technology Center). Jan 1983. 62p. NTIS, PC A04/MF A01. Order Number DE83010521.

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In 1976, when the SOA Lockhopper Valve Testing and Development Project was initiated, the most severe process condition for a lockhopper valve was a differential pressure of 500 psi at an operating temperature of 600°F. In order to maintain acceptable performance at this condition, valves had to be rebuilt approximately every 500 cycles. In the METC stirred, fixed-bed gasifier, lockhopper (feed) valves have accumulated 4500 cycles at maximum pressures of 165 psig with estimated temperatures of 450°F. Cyclone dust removal lockhopper valves have operated successfully for over 4500 cycles with 500° to 700°F solids. SOA test valves have performed well in simulated lockhopper service for 16,000 cycles at pressures to 1000 psig and valve body temperatures to 600°F. This represents a significant improvement since the start of the project. It is believed that at this time valves can be purchased with a potential service life of 15,000 cycles at 1000 psig and 450°F or 200 psig and 1000°F. In order to accomplish the testing necessary to develop valves for these service conditions, METC has constructed facilities that can simulate lockhopper service at pressures up to 2000 psig with up to 600°F simulated feed materials (limestone) or 2000°F simulated ash materials (aluminum oxide or silicon carbide). To date, METC facilities have been used to perform 63 test runs on 36 test valves. Information on test results, new valve designs, materials testing, and pilot-plant experience is being distributed through technical papers, project publications, presentations at Valve Manufacturers Association meetings, and through the sponsorship of conferences.

28804 **(DOE/PC/30232—T6) Pollutants from coal conversion processes. Sixth progress report, 1 December 1982-28 February 1983.** Ferrell, J.K.; Felder, R.M. (USDOE Pittsburgh Energy Technology Center, PA). 1983. Contract FG22-80PC30232. 46p. NTIS, PC A03/MF A01. Order Number DE83008895.

A New Mexico subbituminous coal was gasified with steam and oxygen in a 15.2-cm i.d. fluidized bed reactor at a pressure of 790 kPa (100 psig) and average bed temperatures between 875°C and 990°C. Material balances were obtained on total mass and major elements (C,H,O,N,S). A simple representation of coal pyrolysis has been added to a previously developed model of gasification and combustion; the resulting model provides good correlations of measured carbon conversions, make gas production rates, and make gas compositions. Approximations that can be used to estimate sulfur conversion and the split between H_2S and COS in the product gas have also been developed. The objective of the program is to characterize the gaseous and condensed phase emission rates of various pollutants from the gasification-gas cleaning process and their dispendence on adjustable process parameters.

28805 **(DOE/PC/41263—T2) Novel approaches concerning catalyst deactivation. Quarterly report No. 3, January 1, 1982-April 31, 1982.** Tsotsis, T.T. (University of Southern California, Los Angeles (USA). Dept. of Chemical Engineering). 1982. Contract FG22-81PC41263. 23p. NTIS, PC A02/MF A01. Order Number DE83010891.

We focus our attention on problems of deactivation of catalysts which admit closed-form integral solutions. A solution technique is presented which considerably simplifies the numerical effort involved in the analysis of the problem. For problems of slab

geometry, in particular with randomly distributed pores, in the absence of molecular exclusion effects, an exact analytical solution is derived. To the best of our knowledge this is the first time that an analytical solution for a non-trivial deactivation problem has been developed.

28806 **(DOE/PC/41263—T3) Novel approaches concerning catalyst deactivation. Quarterly report No. 2, September 1, 1981-December 31, 1981.** Tsotsis, T.T. (University of Southern California, Los Angeles (USA). Dept. of Chemical Engineering). 1981. Contract FG22-81PC41263. 67p. NTIS, PC A04/MF A01. Order Number DE83010892.

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In our first quarterly report, we presented a few numerical calculations of our model of a single catalyst pore which undergoes rapid coking, which in turn results to pore plugging and complete deactivation of the pore. In this quarterly report, we focus our attention on a single catalyst particle which lies inside a differential reactor, and investigate the effect that the catalyst particle size and average pore diameter have on the catalyst behavior under deactivation conditions, due to pore volume plugging resulting from coke deposition.

28807 **(DOE/PC/41263—T4) Novel approaches concerning catalyst deactivation. Quarterly report No. 1, May 1, 1981-August 31, 1981.** Tsotsis, T.T. (University of Southern California, Los Angeles (USA). Dept. of Chemical Engineering). 1981. Contract FG22-81PC41263. 23p. NTIS, PC A02/MF A01. Order Number DE83010893.

In our literature survey on the general subject of catalyst deactivation, over 700 papers have been recovered dealing with different aspects of the phenomenon of deactivation. Through the use of Engineering Citation Index we have recovered all papers dealing with the subject by several prominent authors in this area. We have classified the publications recovered in four categories: (1) experimental papers, (2) theoretical papers using the classical differential equation approach, (3)theoretical papers utilizing statistical approaches, and (4) review papers. Most of the experimental literature deals with cracking, hydrogenation and, in a few instances, oxidation reactions. The experimental information on catalyst deactivation provided to us by Polinski and coworkers at PETC has been classified and organized. It was encouraging for us to see that our crude initial effort on deactivation modeling correctly predicted the qualitative trends of the deactivation behavior of the H-Coal Liquefaction process (an approximately linear initial drop in activity followed by a slower loss of activity clearly approaching an asymptotic value). At this point however due to lack of more complete experimental information (especially pore volume, surface area and effectiveness factor versus time on stream data) it is rather difficult for us to make direct comparisons between our more recent theoretical results and the existing experimental information.

28808 **(DOE/PC/50783—T1) Heavy-recycle-solvent studies in two-stage coal liquefaction. Third technical progress report, December 11, 1982-March 10, 1983.** Longanbach, J.R. (Battelle Columbus Labs., OH (USA)). 31 Mar 1983. Contract FG22-82PC50783. 22p. NTIS, PC A02/MF A01. Order Number DE83010222.

Samples of SCT Recycle Solvent and SCT Heavy Oil Product from the Lummus ITSL pilot plant were vacuum distilled to obtain 800⁻ F and 800⁺ F fractions. The 800⁺ fractions are being separated by preparative scale liquid chromatography into aliphatic hydrocarbons, aromatics hydrocarbons, N-containing aromatics and OH-containing aromatics. Identification of the major components of the SCT Recycle Solvent fractions has recently begun. A microautoclave reactor system has been assembled and debugged. An operating procedure has been established. Krypton in hydrogen or helium has been used as an internal standard to facilitate the measurement of gas yields during liquefaction. A procedure has been developed to measure MAF liquefaction conversions (THF solubles), yields of asphaltenes plus preasphaltenes (THF soluble-heptane insolubles) and oils (heptane solubles). Preliminary results based only on the product gas analyses suggest that more hydrogen is produced than consumed in the presence of a helium atmosphere but there is a net consumption of hydrogen in the presence of a hydrogen atmosphere. More CO_2 is also produced in the presence of helium. The effects of using SCT Recycle Solvent versus SCT Heavy Oil Product THF Solubles as the solvent include the production of less hydrogen under helium and the production of more light hydrocarbons with the SCT Heavy Oil Product. Less hydrogen is produced under helium when the 800⁺ F material is included in the solvent.

28809 **(DOE/RA/50339—1387-Vol.1) Integrated gasification combined-cycle power plant at Sears Island, Maine: feasibility study. Final report. Volume I.** (Central Maine Power Co., Augusta (USA)). 30 Mar 1983. Contract FG01-80RA50339. 462p. NTIS, PC A20/MF A01. Order Number DE83010919.

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This report presents the results of a feasibility study to evaluate the use of medium Btu synthesis gas, produced from high-sulfur coal, in an Integrated Gasification Combined Cycle (IGCC) power plant, as an alternative to a conventional pulverized coal plant with flue gas scrubbers presently planned for the Sears Island, Maine site of Central Maine Power Company. The process configuration is based on the oxygen-blown Texaco Coal Gasification Process and a General Electric Combined Cycle power plant. The plant design includes a 5000 ton per day oxygen plant, four 1200 tons per day gasification trains plus one spare to reduce risk, four gas turbine-generators with heat recovery steam generators, and a reheat steam turbine generator. Plant output at ISO (59°F) conditions is 524 MW net. The report includes preliminary design and arrangement drawings, a detailed plant description, detailed cost information, performance data, schedules, and an extensive evaluation of technical, economic, and environmental results. The results of the study indicate that the IGCC power plant is still a rapidly evolving technology. Before Central Maine Power Company can commit to construction of such a plant, several issues raised in the study need to be addressed. These issues deal with refinements in cycle performance, demonstration of various major components, and construction schedule, among others. The IGCC Plant does have less environmental impact than a comparably sized conventional coal plant, while using a high sulfur, high ash, less expensive coal. The life-of-plant levelized busbar cost for the IGCC Plant is estimated to be 5% lower than for the conventional coal-fired plant, although the initial capital cost is approximately 60% higher. Other cycle designs were identified which have the potential for improving plant economics.

28810 **(DOE/RA/50339—1387-Vol.2) Integrated gasification combined-cycle power plant at Sears Island, Maine: feasibility study. Final report. Volume II.** (Central Maine Power Co., Augusta (USA)). 30 Mar 1983. Contract FG01-80RA50339. 342p. NTIS, PC A15/MF A01. Order Number DE83009793.

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Volume 2 contains a discussion of US coal supplies within a reasonable distance, their cost, and transportation method, depending somewhat on the mine location. Also, included are technical and environmental evaluations and comparison with those of a coal-fired plant equipped with a scrubber. Site selection considerations, baseline ecology, permit applications, emissions and air and water pollution control, air and water quality impacts, socio-economic factors, and engineering cost data. The potential for improvements of the combined-cycle plant is considered: increase in temperature on efficiency, advanced gas turbine cycle, acid gas removal (Rectisol II).

28811 **(EUR—7179-e) Relationship between properties of coke oven blends and coke product.** (Commission of the European Communities, Luxembourg). 1981. 104p. Commission of the European Communities, Luxembourg.

The dilation properties of coal blends were examined in terms of the plastic zone characteristics of the component coals. An equation is given for predicting the dilation of binary blends of coals, and procedures are described for evaluating the dilation of blends containing any number of component coals. The use of fluxing additives is one method of enhancing the dilation and coking properties of weakly caking oven charges. The initiation and growth of fissures in coke during the post plastic zone of carbonization is affected, in part by the contraction characteristics of the

newly formed semi-coke. Coke breakage in micum and shatter was also analysed.

28812 (EUR—7184-d) Up-grading of coal through hydrogenation. (Commission of the European Communities, Luxembourg). 1981. 19p. (In German). Commission of the European Communities, Luxembourg.

Laboratory experiments on the hydrogenation of several types of coal to produce liquid distillates in the presence of hydrogen and in an inert aliphatic hydrocarbon solvent such as iso-octan, but in the absence of catalysts, showed a conversion rate of coal of up to 90%. This rate was raised further by catalysts such as zinc chloride and cobalt-molybdenum oxide; corrosion problems with $ZnCl_2$ led to a preference for Co-Mo. Experiments with coal samples with enriched amounts of naturally contained minerals showed that the normal amounts of minerals in coal have a catalysing effect on hydrogenation. The main function of the inert solvent seemed to be to act as carrier phase and to limit amounts of gaseous hydrocarbons to 10% of the product in the absence of a catalyst and to 3% in its presence. Analysis of the 210-270 C fraction after recovery of phenols resulted in 6% saturated compounds: 70% tetralin, 21% naphthalene, 3% biphenyls.

28813 (MTI/WDC—82TR520) Testing of high temperature coal slurry pump packings. Hao, B.R. (Mechanical Technology, Inc., Latham, NY (USA)). Dec 1982. Contract AC22-81PC40090. 206p. NTIS, PC A10/MF A01. Order Number DE83005093.

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This report presents the results of a test program of packing designs and materials for high temperature coal slurry plunger pump services. The work was conducted to support the investigations and development of reliable and cost-effective reciprocating coal slurry pumps for future coal liquefaction process application. The short-term objectives were to screen, test and evaluate the state-of-the-art, commercially available packing designs and materials for the coal slurry feed pumps at the coal liquefaction pilot plants. Four major tasks were completed: failure analysis of slurry feed pumps packing components; selection of commercial packing designs and materials for testing; laboratory testing of high temperature coal slurry pump packings; and field testing of selected coalslurry pump packings. The results are presented. The primary root causes of the packing failures experienced at the pilot plants were identified as: insufficient packing lubrication, ineffective plunger flushing, unstable plunger alignment conditions of the pump, packing material incompatible to slurry and solvent, and undesirable packing installation, start-up, standby, and maintenance.

28814 (ORNL/FMP—83/1) AR and TD Fossil Energy Materials Program. Quarterly progress report for the period ending December 31, 1982. (Oak Ridge National Lab., TN (USA)). Feb 1983. Contract W-7405-ENG-26. 342p. NTIS, PC A15/MF A01. Order Number DE83010406.

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The objective of the AR & TD Fossil Energy Materials Program is to conduct research and development on materials for fossil energy applications with a focus on the longer-term and generic needs of the various fossil fuel technologies. The program includes research aimed toward a better understanding of materials behavior in fossil energy environments and the development of new materials capable of substantial enhancement of plant operations and reliability. The management of the Program has been decentralized to DOE Oak Ridge Operations Office (ORO) and the Oak Ridge National Laboratory (ORNL) as technical support contractor. The ORNL Fossil Energy Materials Program Office compiles and issues this combined quarterly progress report from camera-ready copies submitted by each of the participating subcontractor organizations. It is the intent of the AR & TD Fossil Energy Materials Program to sponsor materials research which is generic to a number of fossil energy technologies. We hope this series of AR & TD Fossil Energy Materials Program quarterly progress reports will aid in the dissemination of information developed on the program.

28815 (SAND—83-0410) Material coatings for valves: coal-liquefaction components and instrumentation. Final report, October 1, 1981-September 30, 1982. Curlee, R.M.; Hawn, D.C. (Sandia National Labs., Albuquerque, NM (USA)). Mar 1983. Contract AC04-76DP00789. 41p. NTIS, PC A03/MF A01. Order Number DE83010288.

This report summarizes activities in the development of erosion-resistant coatings for the wear-prone parts of letdown and control valves used in coal-conversion process plants. Objectives were to demonstrate material and coating process concepts for industrial applications, initially the Exxon Donor Solvent ECLP facility and the Wilsonville pilot plant. Titanium diboride (TiB_2) coatings were deposited on tungsten carbide K701 cermets by chemical vapor deposition, but were not successfully deposited on other carbide substrates of interest, such as K703 and K801. Intermediary buffer coatings of metalic nickel were developed to reduce thermal stress and chemical incompatibilities between TiB_2 coatings and carbide substrates. Hot-pressed TiB_2/Ni cermets were coated by chemical vapor deposition of TiB_2. Simulated slurry-erosion testing of carbide and TiB_2 substrates with TiB_2 coating was performed at Battelle Columbus Labs. Results of these tests showed that TiB_2-coated K701 eroded at one half the rate of the uncoated-K701 reference, and that one TiB_2/Ni cermet showed no wear compared to the reference. Valve trim for the Exxon Donor Solvent ECLP facility was produced and tested under Texas lignite coal during the final 25 days of that plant's operation.

28816 Continuous process for conversion of coal. Baker, G.G.; Farnum, S.A.; Knudson, C.L.; Sondreal, E.A.; Willson, W.G. (to Dept. of Energy). US Patent 4,337,142. 29 Jun 1982. Filed date 29 May 1980. vp.

PAT-APPL-154351.

An improved process for converting coal to liquid and gaseous products wherein the liquid products predominate and wherein reactor, tubing, and valve plugging due to carbonate salt formation is reduced by reacting crushed low-rank coal containing about 12 to 30% by weight of water in a solvent at a temperature in the range of about 455 to 500° C, under about 2000 to 5000 psi pressure of a H_2/CO mixture for a liquid residence time of about 20 to 60 minutes. The solvent is a fraction of liquid product defined on a weight basis as being made up of about 55% of which distills at less than 250° C/1mm, about 20% of which is soluble in thf, and about 25% of which is carbon polymer and indigenous inorganic matter. The solvent is further defined as containing at least about 5 weight % of partially hydrogenated aromatics and/or fully hydrogenated aromatics and little or no alkylated aromatics or higher alkanes.

28817 Process for separating coal synthesized methane from unreacted intermediate and contaminant gases. Barker, R.E.; Ryon, A.D.; Scott, C.D. (to Dept. of Energy). US Patent 4,336,044. 22 Jun 1982. Filed date 27 Oct 1980. vp.

PAT-APPL-200799.

Gas produced from coal and containing CH_4, CO, CO_2, H_2 and H_2S is contacted with CO_2 scrub liquid to form (1) a liquid CO_2 stream containing as solutes CH_4, H_2S and minor portions of the CO and H_2, and (2) a gas stream containing CO_2 and major portions of the CO and H_2, the co and H_2 in this stream being recycled to the means which produces gas from coal, and CO_2 in the stream being recycled to the scrub liquid. The solute-bearing liquid CO_2 stream is fractionated into (1) a liquid CO_2 stream containing CH_4 and H_2S, and (2) a H_2/CO gas stream which is recycled into contact with the scrub liquid. The last-mentioned liquid CO_2 stream is fractionated into (1) a CH_4/CO_2 gas stream the CO_2 of which is recycled to the scrub liquid, and (2) a liquid CO_2 stream containing H_2S, and CO_2 of this stream is also recycled to the scrub liquid.

28818 Method for gasification of deep, thin coal seams. Gregg, D.W. (to Dept. of Energy). US Patent 4,334,579. 15 Jun 1982. Filed date 29 Aug 1980. vp.

PAT-APPL-182561.

A method of gasification of coal in deep, thin seams by using controlled bending subsidence to confine gas flow to a region close to the unconsumed coal face. The injection point is moved sequentially around the perimeter of a coal removal area from a production well to sweep out the area to cause the controlled bending subsidence. The injection holes are drilled vertically into the coal seam

through the overburden or horizontally into the seam from an exposed coal face. The method is particularly applicable to deep, thin seams found in the eastern united states and at abandoned strip mines where thin seams were surface mined into a hillside or down a modest dip until the overburden became too thick for further mining.

28819 **Coal liquefaction in an inorganic-organic medium.** Grens, E.A.; Holten, R.R.; Vermeulen, T. (to Dept. of Energy). US Patent 4,333,815. 8 Jun 1982. Filed date 5 Mar 1979. vp.
PAT-APPL-017299.

Improved process for liquefaction of coal by contacting pulverized coal in an inorganic-organic medium solvent system containing a ZNCl2 catalyst, a polar solvent with the structure RX where X is one of the elements O, N, S or P, and R is hydrogen or a lower hydrocarbon radical; the solvent system can contain a hydrogen donor solvent (and must when RX is water) which is immiscible in the ZNCl2 and is a hydroaromatic hydrocarbon, selected from tetralin, dihydrophenanthrene, dihydroanthracene or a hydrogenated coal derived hydroaromatic hydrocarbon distillate fraction.

28820 **Combustion of medium heating value coal gas at turbine operating conditions.** Schwab, J.A.; Cicero, D.C.; Basel, R.S. (Westinghouse Electr Corp, Madison, PA, USA). *American Society of Mechanical Engineers, [Paper]*; No. 82-GT-197, 1-8(1982). (CONF-820407—).

From 27. ASME international gas turbine conference; London, UK (18 Apr 1982).

The work described in this paper is part of the effort performed under Department of Energy (DOE) Contract DE-AC21-80ETI4752. The primary objective of this contract is to demonstrate the viability of the Westinghouse pressurized, fluidized bed gasification process for production of low and medium heating value fuel gas. One of many secondary objectives is to conduct combustion tests with medium heating value fuel gas produced by the DOE/Westinghouse gasifier. Tests were performed on an experimental Westinghouse combustor. Pollutant emissions and combustion effificiency were evaluated as a function of inlet temperature, air-to-fuel ratio, pressure and reference velocity. Results for medium heating value gas combustion are presented along with combustion test results on distillate and coal derived liquid fuels. 3 refs.

0105 By-products

REFER ALSO TO CITATION(S) 28817

28821 **Determination of extraction equilibria for several metals in the development of a process designed to recover aluminum and other metals from coal combustion ash.** Seeley, F.G.; McDowell, W.J.; Felker, L.K.; Kelmers, A.D.; Egan, B.Z. (Oak Ridge National Lab., TN). *Hydrometallurgy;* 6: 277-290(1981). Contract W-7405-ENG-26.

Laboratory-scale tests of several methods for the recovery of resource materials from fly ash have led to the development of a sinter/dilute acid leach method (Calsinter process) in which fly ash is sintered with a source of calcium oxide ($CaCO_3$, $CaSO_4$, CaO, and/or limestone flue-gas desulfurization scrubber sludge) at 1000 to 1200°C, followed by a two-stage leach of the sintered solids with dilute sulfuric acid. Recovery of aluminum from this leach solution in a relatively pure form requires that several contaminants, particularly iron, must be separated from the aluminum before it can be precipitated. Therefore, distribution coefficients for iron (III) and 16 other metal ions have been determined in the liquid-liquid extraction system: Primene JM-T - toluene versus aqueous ammonium sulfate (and sodium sulfate) as a function of sulfate, acid, metal ion, and amine sulfate concentration. A study of iron (III) loading equilibria as a function of time indicated that equilibrium was essentially achieved in 1 h; however, some changes, probably in the nature of the extracted species, occurred over a period of approximately 20 h. Iron (III) extraction results obtained under various sulfate concentration matrix conditions suggested the formation of an aqueous complex of ferric ammonium sulfate, which depressed iron distribution to the organic phase. Extraction isotherms for Ag, As, Cd, Cr, and Fe all exhibit linearity at low loading conditions with unit slopes, including the same degree of association of the metal ion species in both the organic and the aqueous phase. Other metal ions for which distribution coefficients are reported are: Ba, Mg, Mn, Na, K, P, Pb, Th, Ti, and U.

0106 Properties

REFER ALSO TO CITATION(S) 28797, 28811, 28839, 28840, 28841, 28842, 28843, 28844, 28846, 28848, 28910

28822 **(ACIRL-PR—81-6) 34th meeting of the International Committee for Coal Petrology, Pau, France: and aspects of carbonisation and petrographic research at selected centres in Europe.** Handley, K. (Australian Coal Industry Research Labs. Ltd., North Ryde). Aug 1981. 22p. Australian Coal Industry Research Labs. Ltd., North Ryde.

The author attended the 34th Meeting of the ICCP held in Pau, France, in April 1981. He reports on the initiation of a working group to study coal hydrogenation residues and describes the work of a number of other working groups. Subsequent visits were made to select research centres in Germany and the UK (including a visit to the NCB Coal Research Establishment) to study developments in areas of research relevant to ACIRL's research programme.

28823 (CONF-811122—Pt.2, pp 12-23) **Characterization of flyashes.** Diamond, S. (Purdue Univ., West Lafayette, IN). 1981. Secretariat, Materials Research Society, 102C Materials Research Lab., University Park, PA 16802. Contract AC02-78CS40222.

From Annual meeting of the Materials Research Society; Boston, MA, USA (16 Nov 1981).

Flyash characterization from the point of view of use in concrete is informally explored in this paper. The composition and characterization of the inorganic components of coals are explored, and the nature of the minerals present described at some length. The processes involved in generation of the flyash in power plants are indicated. Typical morphologies of characteristic types of flyash particles are illustrated by scanning electron micrographs. The types of crystalline components present in low-calcium and in high-calcium flyashes are described and contrasted, and attention is called to differences in the glass structure between the two varieties. Reactions involving flyashes in hydrating cement systems are briefly outlined.

28824 (CONF-811122—Pt.2, pp 24-33) **Physical and chemical behavior of selectively etched fly ashes.** Scheetz, B.E.; Strickler, D.W.; Grutzeck, M.W.; Roy, D.M. (Pennsylvania State Univ., University Park). 1981. Secretariat, Materials Research Society, 102C Materials Research Lab., University Park, PA 16802.

From Annual meeting of the Materials Research Society; Boston, MA, USA (16 Nov 1981).

Three fly ashes (lignite, bituminous and anthracite coals) have been characterized using x-ray diffraction (XRD), scanning electron microscopy (SEM) and select leaching with hydrofluoric acid, acetic acid and oxalic acid. All samples have an average particle size of about 10 micrometers and approximately the same size distributions as determined by the automated SEM. The anthracite and bituminous fly ashes consist primarily of quartz and mullite (an aluminosilicate phase) plus glass which were probably derived from the clays and quartz contained as minerals in the original coals, while the predominant phase in the lignite fly ash is a calcium aluminosilicate phase. Since lignites normally contain a high percentage of calcium, this phase is the result of melting clay mierals in the presence of the calcium from the coal. Leaching with the various acids had very little effect on the phases present. As expected, the HF leaching tends to remove the silicate phases while neither the acetic nor oxalic acid had any significant effect on these fly ashes.

28825 (CONF-811122—Pt.2, pp 34-44) **Distinction in physical and chemical characteristics between lignitic and bituminous flyashes.** Diamond, S.; Lopez-Flores, F. (Purdue Univ., West Lafayette, IN). 1981. Secretariat, Materials Research Society, 102C Materials Research Lab., University Park, PA 16802. Contract AC02-78CS40222.

From Annual meeting of the Materials Research Society; Boston, MA, USA (16 Nov 1981).

A small suite of flyashes has been studied intensively to document differences between high-calcium flyashes generally derived from lignite and sub-bituminous coals and the more familiar low-calcium flyashes derived from bituminous coals. The first group has much higher calcium and lower silica and alumina contents, and some have appreciable alkali and sulfate contents. They have high apparent specific gravities, indicating the virtual absence of hollow particles. Crystalline components identified include reactive calcium-bearing compounds including calcium aluminates, free CaO, anhydrite, and others. Crystalline alkali sulfates are found, and these may occur as deposits external to the flyash spheres. In contrast, the low-calcium flyashes examined have simpler suites of crystalline components, restricted largely to quartz, mullite, iron oxides, and a few inert minor compounds. The glass, which appears to be the major component in all of the flyashes, gives a substantially different x-ray scattering trace for the high-calcium flyashes, which may indicate that its structure is substantially different from that of common siliceous glasses.

28826 (CONF-811122—Pt.2, pp 45-52) **Properties of fly ash used in Germany.** Wesche, K.; vom Berg, W. (Aachen Technical Univ., Germany). 1981. Secretariat, Materials Research Society, 102C Materials Research Lab., University Park, PA 16802.

From Annual meeting of the Materials Research Society; Boston, MA, USA (16 Nov 1981).

According to the German standard for concrete constructions (DIN 1045) fly ashes having an approval can be used as a concrete admixture. This approval is granted to the fly ash of a single boiler if it fulfills a set of requirements. The properties of all fly ashes used in concrete must be continously inspected. On the basis of the large number of test results performed in connection with this continuous monitoring, a survey is given of the properties of coal fly ashes from 14 power plant boilers. This survey contains information about chemical composition and physical and mineralogical properties of fly ashes and some relevant properties of cement pastes and mortars containing fly ash. In addition correlations between different fly ash properties are shown and discussed with regard to concrete technology and to the current control of fly ash.

28827 (CONF-830308—10) **Rheology of coal slurries at process temperatures and pressures.** Lee, D.D.; Gibson, M.R.; Sams, T.L.; Wilson, J.H. (Oak Ridge National Lab., TN (USA)). 1983. Contract W-7405-ENG-26. 40p. NTIS, PC A03/MF A01. Order Number DE83010141.

From American Insititute of Chemical Engineers national meeting; Houston, TX, USA (27 Mar 1983).

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In support of the SRC-I Demonstration Plant Project, rheological and density measurements have been made on recycle solvent and slurries made with Kentucky No. 9 coal at a 1.6 solvent-to-coal ratio. The measurements were made at temperatures of 300 to 758°K and pressures of 0.1, 1.1, 7.0, and 17.3 MPa. Reaction-time effects were studied by changing the residence time in the preheater above a given temperature. Results show that the solvent behaved as a Newtonian fluid, while the slurry behaved in a non-Newtonian pseudoplastic manner dependent on temperature and reaction time. The viscosity of the slurry increased by over 100 times in the gel region at low reaction times. Also, the slurry density exhibited a more-rapid decrease with temperature in this gel region compared to the region before the reaction began.

28828 (DOE/PC/30223—7) **Petrographic characterization of Kentucky coals. Quarterly progress report, December 1982 to February 1983.** Hower, J.C.; Ferm, J.C.; Cobb, J.C.; Trinkle, E.J.; Frankie, K.A.; Poe, S.H.; Baynard, D.N.; Graese, A.M.; Raione, R.P. (Kentucky Univ., Lexington (USA). Inst. for Mining and Minerals Research). 1983. Contract FG22-80PC30223. 17p. NTIS, PC A02/MF A01. Order Number DE83008762.

The project Petrographic characterization of Kentucky coals consists of three specific areas of coal petrology: spectral fluorescence of liptinite macerals, properties of semi-inert macerals, and size/form/microlithotype association of pyrite/marcasite. Additional research on the Mannington and Dunbar coals in western Kentucky and the Alma coal zone in eastern Kentucky will apply techniques developed in the first three areas. Suites of coals from other states will also be studied to expand the variability in the sample set. Due to the discrete nature of the projects, the final reports will be submitted in several parts. The first report on spectral fluorescence is in development and should be submitted prior to the end of the project. The other reports will be submitted shortly after the end of the project.

28829 (DOE/PC/30249—T5) **Development of a thermodynamic properties correlation framework for the coal conversion industry. Phase III. Third semi-annual report, September 1, 1982-February 28, 1983.** Starling, K.E.; Lee, L.L.; Watanasiri, S.; Kumar, K.H.; Brule, M.R.; Luong, T.H.; Kache, A.; Owens, V.H.; Tran, T.; Becraft, W.R. (Oklahoma Univ., Norman (USA). School of Chemical Engineering and Materials Science). 1983. Contract FG22-80PC30249. 75p. NTIS, PC A04/MF A01. Order Number DE83008160.

Our research efforts were directed towards: application of the multiparameter corresponding-states thermodynamic-property correlation developed in 1982 to highly nonideal binary mixtures; and development of correlations to estimate characterization parameters used in the multiparameter corresponding-states correlation for undefined fractions. In the mixture study, a local-composition model (LCM, from two-fluid theory) and a conformal-solution model (CSM, from one-fluid theory) were used to describe phase behavior of highly nonideal binary mixtures. The LCM has been shown to work well for nonideal mixtures by previous investigators. In this work, we investigate the feasibility of using LCM in our correlation framework, and compare the accuracy of the LCM with the CSM. Our proposed LCM introduces density and temperature dependence into the mixing rules and requires a maximum of three adjustable parameters. For nine highly nonideal binary mixtures tested, two of which contain model coal compounds, the LCM generally provides better results than the CSM. In applying the thermodynamic correlation to full-range coal fluids, characterization parameters are needed for each fraction. Correlations were developed to estimate fraction critical constants, acentric factor, structure factor, and dipole moment as functions of inspection data such as molecular weight, normal boiling point, and specific gravity. The correlations developed provide greater accuracy than the existing correlations. Appendixes A and B have been entered separately.

28830 (DOE/PC/30249—T5, pp 39p, Paper 1) **Study of the application of the local composition model for the MPCS-MBWR equation of state for mixture.** Luong, T.H. 1983. NTIS, PC A04/MF A01.

In Development of a thermodynamic properties correlation framework for the coal conversion industry. Phase III. Third semi-annual report, September 1, 1982-February 28, 1983.

A local composition two-fluid model has been used in a multi-parameter corresponding-states MBWR (MPCS-MBWR) equation to predict the thermodynamic properties of polar and non-polar fluid mixtures. The local composition model introduces density and temperature dependence into the mixing rules. The resultant composition dependence is applicable to high-density fluids and is reduced to the conventional one-fluid mixing rules in the low-density limit. Two adjustable parameters are required for strongly nonideal mixtures, but three parameters are needed for some systems. The method has been used to correlate vapor-liquid equilibrium (VLE) data for nine asymmetric mixtures covering all fluid densities. A conformal solution one-fluid model was also used with the

MPCS-MBWR equation to correlate the VLE data. The local composition model generally provides better results than the classical one-fluid model. Data for ethane-acetane; ethane-methanol; CO_2-methanol; cyclohexane-aniline; hydrogen sulfide-actic; ammonia-water; toluene-aniline binary mixtures over full composition range at various temperatures and over a pressure range.

28831 (DOE/PC/30249—T5, pp 24p, Paper 2) **Correlations for estimating critical constants, acentric factor, structure factor, and dipole moment for undefined fractions.** Owens, V.H.; Watanasiri, S.; Starling, K.E. 1983. NTIS, PC A04/MF A01.

In Development of a thermodynamic properties correlation framework for the coal conversion industry. Phase III. Third semi-annual report, September 1, 1982-February 28, 1983.

Correlations have been developed to estimate critical constants, acentric factor, structure factor, and dipole moment of model coal compounds and other hydrocarbons and derivatives. The correlations are functions of normal boiling point, specific gravity and molecular weight. These quantities are normally measured for undefined petroleum and coal-fluid fractions. Previous correlations for critical constants and acentric factor are applicable only to petroleum fractions and nonpolar coal-fluid fractions. The present correlations extend the range of application to polar and associating fluids. The structure factor and dipole moment are characterization parameters specific to a new equation of state for nonpolar, polar, and associating coal fluids. The dipole moment correlation is the only such correlation available in the literature.

28832 (DOE/PC/50789—T1) **Depolymerization of coal by direct solvent attack. Semi-annual report for the period September 1, 1982-March 30, 1983.** Larsen, J.W. (Tennessee Univ., Knoxville (USA). Dept. of Chemistry). 6 Apr 1983. Contract FG22-82PC50789. 14p. NTIS, PC A02/MF A01. Order Number DE83009746.

The depolymerization of bituminous coals by pyridine shows a strong dependence on the concentration (gas density) of the supercritical solvent suggesting solvolysis reactions are occurring. With Illinois No. 6 coal at 350°C for 4 hours (rho = 0.8 g/ml), conversions as high as 65% wee observed. Our first experiments with aliphatic amines showed much higher conversions under milder conditions. For example, at 300°C for 3 hours (rho = 0.2 g/ml) triethylamine solubilizes 88% of the coal. These remarkably high conversions are common with amines. Alcohols, detailed data for which will be included in the next report, show much lower conversions.

28833 (DOE/PC/50789—T1, pp 10) **Depolymerization of coals in hot pyridine.** Larsen, J.W. (Tennessee Univ., Knoxville); Yurum, Y.; Sams, T.L. 6 Apr 1983. NTIS, PC A02/MF A01.

In Depolymrization of coal by direct solvent attack. Semi-annual report for the period September 1, 1982-March 30, 1983.

Coals are readily depolymerized by heating in a variety of solvents. We report here the depolymerization of three coals caused by heating the coal in pyridine at 350°C and the existence of reactions which result in the scrambling of pyridine hydrogens during the depolymerization. The fact that the extent of depolymerization is dependent on the pyridine concentration (gas density) raises the possibility of a previously unconsidered mechanism for coal depolymerization: cleavage of bonds due to solvent attack. A dependence of conversion on solvent concentration has also been observed with phenol. The data reported here are not sufficient to establish the nature of the chemical reactions responsible for either the depolymerization or the H-D scrambling. We do not even know whether the same reactions are responsible for both processes. The experimental observations reported are novel, interesting, and relevant to the depolymerization of coals upon heating in solvents.

28834 (DOE/PETC/TR—83/4) **Analysis of tipple and delivered samples of coal collected during fiscal year 1981.** Welsh, R.A. (Department of Energy, Pittsburgh, PA (USA). Pittsburgh Energy Technology Center). Nov 1982. 27p. NTIS, PC A03/MF A01. Order Number DE83009749.

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This Department of Energy (DOE) publication updates a series of Topical Reports (formerly Reports of Investigation) on the quality of coal purchases under specifications for government use. Listed in alphabetical order by state, county, town, and mine are analytical data on the composition and quality of tipple and delivered samples of coal collected during fiscal year 1981. Tipple samples were collected by a commercial laboratory under contract in accordance with instructions furnished by the Coal Sampling and Inspection Office (CSIO). The delivered samples were collected at destination by installation personnel, and all samples were analyzed in the DOE laboratory located in Pittsburgh, Pennsylvania.

28835 **New viscometer for determining the effect of particle size distributions and concentration on slurry rheology.** Hanks, R.W.; Hanks, K.W. (Brigham Young Univ., Provo, UT). pp 151-161 of Seventh international technical conference on slurry transportation. Proceedings. Sakkestad, B.A. (ed.). Washington, DC; Slurry Transport Association (1982).

From 7. international technical conference on slurry transportation; Lake Tahoe, NV, USA (23 Mar 1982).

A unique new capillary viscometer has been developed which produces continuous, nearly instantaneous, direct measurements of pressure gradients and mass flow rates. This instrument is especially well-suited for the study of slurry rheology because no corrections are required as in conventional capillary viscometers. The rapid response time and short time required for measurement make it possible to obtain large amounts of data in a short time. The viscometer has been used to investigate the effect of particle size distribution on Utah coal-water slurry rheology. For a Black Mesa distribution it was found that only the -325m particles are rheologically active. The remaining particles, which are considered coarse, can and do contribute to the overall hydraulic resistance of coal slurries, but they do so through heterogeneous flow phenomena, not rheological phenomena. The concept of equivalent total slurry concentration has been introduced and found to be effective in quantifying the vehicle concept originally proposed by Wasp. Water slurries of Utah (Orangeville, Emery County) coal were found to exhibit classical rheological dilatancy (shear-thickening behavior) without the presence of a yield stress. This result is in direct contrast to previously reported results for slurries of similar coals. The data were well correlated as functions of concentration and shear-rate using the Cross model. The present results indicate that previous rheological studies of coal-water slurries may be open to question and further careful study of this important area of coal slurry technology is needed. It is possible that pipeline projections based upon the questionable rheological data may likewise be open to question.

28836 **Identification and quantification of polynuclear aromatic compounds in synthoil by room-temperature phosphorimetry.** Vo-Dinh, T.; Gammage, R.B.; Martinez, P.R. (Oak Ridge National Lab., TN). *Analytica Chimica Acta;* **118**: 313-323(1980). Contract W-7405-ENG-26.

Room-temperature phosphorimetry (r.t.p.) is used to identify and quantify polynuclear aromatic compounds in a synthetic fuel (Synthoil). Several trace and major components, benzo[a]pyrene, chrysene, fluorenes, fluoranthene, phenanthrene, and pyrene, have been identified and determined at concentrations ranging from tens to thousands of parts-per-million. The selectivity of the r.t.p. analysis is greatly improved by using selective heavy-atom perturbation and synchronous excitation scanning.

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REFER ALSO TO CITATION(S) 28823, 28824, 28825, 28826, 30338, 30591

28837 (CONF-811122—Pt.2) **Effects of flyash incorporation in cement and concrete.** Diamond, S. (ed.). (Materials Research Society, University Park, PA (USA)). 1981. 336p. Secretariat, Materials Research Society, 102C Materials Research Lab., University Park, PA 16802.

From Annual meeting of the Materials Research Society; Boston, MA, USA (16 Nov 1981).

This symposium dealt with the properties of flyash; flyash reactions with cements and cement components including reaction

kinetics and microstructure formation; the effects of flyash incorporation on the properties and performance of concretes (e.g., curing time, water requirements, temperature effects, strength properties, shrinkage, air entrainment, and wear resistance); global aspects, standardization, and practical experience in the utilization of flyash in concretes; and properties of other mineral wastes related to flyash. Separate abstracts were prepared for most of the 33 papers presented. 279 references. (CKK)

28838 (CONF-811122—Pt.2, pp 2-11) **Production and collection of fly ash for use in concrete.** Ravina, D. (Technion-Israel Inst. of Tech., Halfa, Israel). 1981. Secretariat, Materials Research Society, 102C Materials Research Lab., University Park, PA 16802.

From Annual meeting of the Materials Research Society; Boston, MA, USA (16 Nov 1981).

The setup of an electrical power station and the processes and operations involved are described from the viewpoint of their effect on the properties of the fly ash. The systems for collection, handling, beneficiation and storage are analyzed and their effect on the fly ash is evaluated. It is shown that suitable design of the collection and delivery system for new installations (or, in some cases, modification of the existing one) will lead to significant improvement in the quality of the fly ash as a concrete ingredient.

28839 (CONF-811122—Pt.2, pp 54-59) **Pastes of tricalcium silicate with fly ash - analytical electron microscopy, trimethylsilyation and other studies.** Mohan, K.; Taylor, H.F.W. (Univ. of Aberdeen, Scotland). 1981. Secretariat, Materials Research Society, 102C Materials Research Lab., University Park, PA 16802.

From Annual meeting of the Materials Research Society; Boston, MA, USA (16 Nov 1981).

Pastes of tricalcium silicate (Ca_3SiO_5) with a fly ash of high glass content, in weight ratio 3:1 and water: solids ratio 0.5, were cured for 1 to 397 at 25°C and examined by analytical transmission electron microscopy, trimethylsilylation. X-ray diffraction, thermal gravimetric analysis, and chemical determinations of unreacted fly ash. 48% of the fly ash had reacted in 397 days. The results confirm earlier observations that partial replacement of C,S by fly ash accelerates reaction of the Ca_3SiO_5 much reduces $Ca(OH)_2$ content and accelerates polymerization of the silicate ions. The mean Ca:Si ratio of the Ca-Si-H lowered from about 1.51 to about 1.43, apparently independent of time in both cases. At early ages, small amounts of AFt and AFm phases are formed, but by 90 days all the Al, Fe and SO_4 supplied by the fly ash have been incorporated into the Ca-Si-H.

28840 (CONF-811122—Pt.2, pp 60-70) **Hydration of tricalcium silicate in the presence of fly ash.** Jawed, I.; Skalny, J. (Martin Marietta Labs., Baltimore, MD). 1981. Secretariat, Materials Research Society, 102C Materials Research Lab., University Park, PA 16802.

From Annual meeting of the Materials Research Society; Boston, MA, USA (16 Nov 1981).

The hydration of tricalcium silicate (Ca_3SiO_5) in presence of two class F fly ashes of similar chemical and minerlogical compositions but different surface areas was studied in water and NaOH solution. Both fly ashes retarded the Ca_3SiO_5 hydration to the same extent in water but to a different extent in NaOH solution, the one with higher surface area showing more retardation. The results were attributed to the differences in the dissolution behavior of the two fly ashes. The retardation of Ca_3SiO_5 hydration is interpreted in terms of delayed nucleation and growth of $Ca(OH)_2$ and C-S-H in the presence of fly ash.

28841 (CONF-811122—Pt.2, pp 71-81) **Influence of pulverised fuel ash on the hydration reactions of calcium aluminates.** Plowman, C.; Cabrera, J.G. (Univ. of Leeds, England). 1981. Secretariat, Materials Research Society, 102C Materials Research Lab., University Park, PA 16802.

From Annual meeting of the Materials Research Society; Boston, MA, USA (16 Nov 1981).

The general chemical reactions upon hydration of calcium aluminates ($CaAl_2O_4$) synthetically are similar to those of $CaAl_2O_4$ produced in a cement kiln; both hydrations are diffusion-controlled, but the rate of reaction of the kiln-produced material is much faster. There are differences in the morphologies of the metastable intermediates and final products of the reaction. The hydration rate of kiln-produced $CaAl_2O_4$ is approximately seven times faster than that of C_4AF. Pulverized fuel ash is a more effective retarder of hydration of $CaAl_2O_4$ and C_4AF than gypsum. A mechanism is suggested in whih the retarding layer is not ettringite, but consists of lamellar C_4AH/sub x/, which is stabilized by the lack of water in the vicinity of the hydrating system due to formation of calcium sulphoaluminate hydrates. This mechanism appears also to be valid for organic retarders.

28842 (CONF-811122—Pt.2, pp 82-91) **Studies of the hydration reactions and microstructure of cement-flyash pastes.** Ghose, A.; Pratt, P.L. (Imperial Coll. of Science and Tech., London, England). 1981. Secretariat, Materials Research Society, 102C Materials Research Lab., University Park, PA 16802.

From Annual meeting of the Materials Research Society; Boston, MA, USA (16 Nov 1981).

The hydration reactions and the microstructural development in a cement-flyash paste have been studied. There is calorimetric evidence of a pozzolanic reaction between 1 and 2 days. However definite signs of reaction are seen on some of the pulverized fuel ash (PFA) spheres as early as 4 hours. The pozzolanic reaction is a very slow process in that complete consumption of PFA has not been achieved even at 5 months.

28843 (CONF-811122—Pt.2, pp 92-101) **Hydration mechanisms of high-lime fly ash in Portland-cement composites.** Grutzeck, M.W.; Roy, D.M.; Scheetz, B.E. (Pennsylvania State Univ., University Park). 1981. Secretariat, Materials Research Society, 102C Materials Research Lab., University Park, PA 16802.

From Annual meeting of the Materials Research Society; Boston, MA, USA (16 Nov 1981).

The hydration of a high-lime fly ash in three cement pastes was studied by detailed scanning electron microscope microstructural observations, as well as compressive strength and x-ray diffraction. A phenomenological, yet empirical model of fly ash hydration was proposed. As the ash sphere was attacked by pore solutions, the glass was consumed and replaced by radiating bundles of C-S-H fibers arranged in a honeycomb network. Depending upon the age of the cement past matrix and the relative thickness of the fly ash rim, either pull-out or cross-sectional features were developed. Indications are that the reaction mechanism for radial C-S-H growth is both solution and topochemical in nature. The presence of an interfacial region which is bonded to the glass sphere is postulated.

28844 (CONF-811122—Pt.2, pp 102-111) **Hydration reactions in flyash-Portland cements.** Abdul-Maula, S.; Odler, I. (Technical Univ., Clausthal, Germany). 1981. Secretariat, Materials Research Society, 102C Materials Research Lab., University Park, PA 16802.

From Annual meeting of the Materials Research Society; Boston, MA, USA (16 Nov 1981).

The hydration and strength development of a series of laboratory made flyash-portland cements containing flyashes of different origin and composition were studied. It was found that significant variations in the oxide and phase composition of the flyashes had only little effect on the hydration process and strength development of the resultant flyash-portland cements.

28845 (CONF-811122—Pt.2, pp 112-123) **Comparative studies of the effects of lignitic and bituminous flyashes in hydrated cement systems.** Diamond, S.; Lopez-Flores, F. (Purdue Univ., West Lafayette, IN). 1981. Secretariat, Materials Research Society, 102C Materials Research Lab., University Park, PA 16802. Contract AC02-78CS40222.

From Annual meeting of the Materials Research Society; Boston, MA, USA (16 Nov 1981).

This paper reports of examinations on the comparative effects in hydrating cement systems of a small suite of well characterized high-calcium and low-calcium flyashes used as 30% replacement for portland cement. All of the flyashes retarded the initial set of pastes by 2 hours or more, and the final set by at least 5 hours.

In some cases final set was delayed until after the main heat evolution maximum was recorded. Low-calcium flyashes appeared to act as inert diluents in terms of early heat generation, but the high-calcium flyashes contributed substantially to early heat evolution. Rate of development of hydration products, as monitored by non-evaporable water measurements, was almost the same for pastes with high-calcium flyashes as for reference portland cement pastes without flyash; pastes with low-calcium flyash developed hydration products more slowly. By 7 days the strengths of mortars made with high-calcium flyashes had overtaken that of the reference mortars. By six months all of the flyash-bearing mortars had equalled or exceeded the reference mortar strenght, although comparative strength development in concretes was slower. Long-term pore solution analyses indicated that two of the high-calcium flyashes contributed substantial alkali to pore solutions, in one case raising the alkali hydroxide concentration by a factor of about 3. This flyash resulted in significant alkali-aggregate expansion being developed when incorporated in mortar bars with reactive opal, even with a relatively low alkali portland cement. Low-calcium flyashes did not release alkalies to the pore solution, despite their substantial potassium oxide contents.

28846 (CONF-811122—Pt.2, pp 124-133) **Pore structure formation during hydration of fly-ash and slag cement blends.** Feldman, R.F. (National Research Council of Canada, Ottawa, Ontario). 1981. Secretariat, Materials Research Society, 102C Materials Research Lab., University Park, PA 16802.

From Annual meeting of the Materials Research Society; Boston, MA, USA (16 Nov 1981).

Three mixes, a reference cement, one fly-ash blend containing 35% fly-ash, and one with 70% slag, were cured in water at 21, 35 and 55°C at a water/solid ratio of 0.45. After 2, 7, 14, 28, 90, 180, 365 and 550 days, $Ca(OH)_2$ content, porosity, pore size distribution, compressive strength, Young's modulus and microhardness of the products wre determined. The logarithms of these mechanical properties were plotted against porosity. Higher temperature increased the rate of reaction of the reference cement for up to two days, then retarded it. This acceleration period was considerably extended for the cement blends. Mechanical properties at zero porosity were gernally improved in blends hydrated at room temperature; and all blends had a finer pore and lower $Ca(OH)_2$ content than the cement specimen.

28847 (CONF-811122—Pt.2, pp 134-144) **Natural pozzolanas and fly ashes: analogies and differences.** Costa, U.; Massazza, F. (Italcementi, Bergamo, Italy). 1981. Secretariat, Materials Research Society, 102C Materials Research Lab., University Park, PA 16802.

From Annual meeting of the Materials Research Society; Boston, MA, USA (16 Nov 1981).

Like natural pozzolanas, fly ashes react with lime and harden in the presence of water. Nevertheless the two materials show some appreciable differences because the former react with lime and harden at higher initial rate. The differences tend to disappear with time. Pozzolanas mixed with portland cement react with the hydrolysis lime more quickly than fly ashes. The developement of mechanical strengths is about equal. Nevertheless, if pozzolanas are interground with clinker and gypsum they give lower strengths than fly ashes as from three days. The observed differences demand additional studies to explain their origin.

28848 (CONF-811122—Pt.2, pp 145-154) **Combined lime and specific surface area of the hydration products of lime-pozzolana and lime-fly ash mixes.** Tognon, G.; Ursella, P. (Italcementi, Bergamo, Italy). 1981. Secretariat, Materials Research Society, 102C Materials Research Lab., University Park, PA 16802.

From Annual meeting of the Materials Research Society; Boston, MA, USA (16 Nov 1981).

Two samples of natural pozzolanas and two samples of fly ashes were considered. These materials were mixed with lime in the ratios of 100 weight parts of pozzolana or fly ahes to 10, 30, 45, 60 weight parts of $Ca(OH)_2$. These mixes were hydrated in bottles at a water/solid ratio equal to 12.5. The combined lime and the BET specific surface of the mixes were determined at different ages from 3 hours to 12 months. The absorption and deabsorption curves by N_2 were determined at two month-age. The percentages of lime absorbed under equilibrium conditions depend on the nature of the considered pozzolana or fly ash. Fly ashes compared with pozzolanas show slower kinetics which begins after a dormant period of about 30 days. From the analysis of the absorption and deabsorption curves one tried to evaluate the morphology of the hydration products.

28849 (CONF-811122—Pt.2, pp 166-171) **Effect of fly ash on the setting time of concrete - chemical or physical.** Dodson, V.H. (W.R. Grace & Co., Cambridge, MA). 1981. Secretariat, Materials Research Society, 102C Materials Research Lab., University Park, PA 16802.

From Annual meeting of the Materials Research Society; Boston, MA, USA (16 Nov 1981).

All conditions being equal, i.e., the same cement, sand, coarse aggregate, water and temperature, the setting time of plain non-admixtured concrete is a function of its cement factor (C.F.) and its water/cement (w/c) ratio. As the C.F. of a series of plain concretes is increased, the setting times of those concretes decrease. On the other hand, as the w/c ratio of a series of plain concretes is increased, the time of set of the concretes is extended. When the setting times of a given series of plain concretes are plotted as a function of their cement factors divided by their w/c ratios, a straight line relationship is obtained. This straight line, or base line, can then be used to determine whether a given fly ash is altering the setting time of concrete by chemical processes or the result of what was done to the concrete to accommodate the fly ash, i.e., lowered C.F. and increased w/c ratio. If the setting time data point for the fly ash concrete falls on the base line its setting time is the result of the physical aspect. When the data point falls significantly below or above the base line, chemical interations between the cement and fly ash or between the fly ash and water, in addition to the physical effects are influencing the setting time of the concrete.

28850 (CONF-811122—Pt.2, pp 172-183) **Fly ash concrete under hot weather conditions.** Ravina, D. (Technion-Israel Inst. of Tech., Haifa). 1981. Secretariat, Materials Research Society, 102C Materials Research Lab., University Park, PA 16802.

From Annual meeting of the Materials Research Society; Boston, MA, USA (16 Nov 1981).

Hot weather gives rise to problems in manufacturing, placing and curing portland cement concrete, in that it can adversely affect the properties and serviceability of the hardened material. Fly Ash (class F) from bituminous coal, by its nature, has a lower reaction rate compared to portland cement, thus developing its cementitious properties more slowly. This feature and its consequences, which are regarded as disadvantageous in a moderate and particularly in a cold climate, may be beneficial in a hot one and alleviate some of the problems and difficulties in hot-weather concreting. The present work deals with the properties of fresh and hardened concretes, in which up to 30 percent of the ordinary portland cement was replaced by fly ash and which were mixed and cast at 20°C (68°F), and 40°C (104°F). It was found that slump decrease was smaller in the fly ash concretes; that the amount of mixing water to maintain a given slump at elevated temperature has to be increased also in fly ash concrete; and that the compressive strength of a constant water content fly ash concrete was not affected by the elevated temperature, while the strength of a constant consistency (slump) fly ash concrete was reduced.

28851 (CONF-811122—Pt.2, pp 184-193) **Strength contribution of fly ash concrete - a new approach to its estimation.** Dodson, V.H. (W.R. Grace & Co., Cambridge, MA). 1981. Secretariat, Materials Research Society, 102C Materials Research Lab., University Park, PA 16802.

From Annual meeting of the Materials Research Society; Boston, MA, USA (16 Nov 1981).

When the same concrete materials (i.e., cement, sand, coarse aggregate) and curing conditions are employed in fabricating a series of non-admixtured concretes, the compressive strengths of those concretes, at any age of test, are a straight line function of their Omega Index Factors. The Omega Index Factor (O.I.F.) of a given concrete is calculated by dividing its cement factor by its water/cement ratio. The position and slope of the x-y plot of com-

pressive strength vs O.I.F. varies with different cements. The straight line plots for the plain concretes can then be used to evaluate a given fly ash. For example, when concrete in which a portion of the cement is replaced with fly ash, is subjected to this type of analysis, the fly ash concrete data point will either fall on the straight line plots for the plain concretes, indicating no strength contribution, or above the straight line plots, indicating a definite strength contribution. The distance of the fly ash data point from the base line at the same O.I.F. can be used to estimate the magnitude of the strength contribution of the fly ash. The strength contributions of several different fly ashes to concrete, after 1, 7, 28 and 90 days moist cure, are reported and compared with the strength contribution of portland cement at the same ages of test.

28852 (CONF-811122—Pt.2, pp 194-203) **Flyash in cement pastes - some effects of particle size and distribution.** Montgomery, D.G. (Univ. of Wollongong, Australia). 1981. Secretariat, Materials Research Society, 102C Materials Research Lab., University Park, PA 16802.

From Annual meeting of the Materials Research Society; Boston, MA, USA (16 Nov 1981).

The effects of particle size and distribution for four Australian flyashes are examined. In the as-received condition, particle size distributions for the individual flyashes were different. Cement/flyash paste cubes, containing various F/(C+F) (flyash to cement plus flyash) ratios, exhibited variations in strength properties when tested in uniaxial compression. In order to examine the effect of particle size distribution on strength, each flyash sample was separated into discreet particle size ranges using an air classifier. The flyashes were subsequently reconstituted to produce essentially consistent particle size distributions for the four types of ash. Cement/flyash paste cubes, of the same F/(C+F) ratios as for those containing as-received flyash, were tested in uniaxial compression. For both series of tests, specimens were cured, at two temperatures, in water and tested at regular time intervals to determine the amount of compressive strength increase. The paper presents details of the methods involved during the testing program and preliminary results obtained for the size distribution analyses and compressive strength testing.

28853 (CONF-811122—Pt.2, pp 204-213) **Moisture related movements in OPC/PFA concrete.** Ong, L.T.; Munday, J.G.L.; Dhir, R.K. (Dundee Univ., Scotland). 1981. Secretariat, Materials Research Society, 102C Materials Research Lab., University Park, PA 16802.

From Annual meeting of the Materials Research Society; Boston, MA, USA (16 Nov 1981).

The paper deals with movements in OPC/PFA concretes caused by continuous drying and alternate wetting and drying, comparison being sought with the corresponding OPC concretes. It is shown that drying shrinkage is related to the equivalent cement content of the concrete but cannot be related to any other single fly ash characteristic. There is an optimum level of cement replacement by flyash which improves the resistance of concrete to wetting/drying expansion.

28854 (CONF-811122—Pt.2, pp 214-224) **Properties of fly ash concrete.** Crow, R.D.; Dunstan, E.R. Jr. 1981. Secretariat, Materials Research Society, 102C Materials Research Lab., University Park, PA 16802.

From Annual meeting of the Materials Research Society; Boston, MA, USA (16 Nov 1981).

The Bureau of Reclamation has been utilizing fly ash in concrete since the repair of Hoover Dam spillway in 1942; since that time our knowledge of its qualities, physical and chemical characteristics, and finished product properties has greatly expanded. Current performance evaluations of several concrete structures in which class F fly ash was used in quantities up to 30 percent of the cementitious materials lend insight on the properties of fly ash concrete. More recent fly ash projects include research into the characteristics of the class C ash. There are pronounced differences between the class C and F ashes, the most significant of which is class C ashes are cementitious on their own. Properties discussed and compared include sulfate resistance, compressive strength, drying shrinkage, and freeze-thaw durability. Fly ash is a plentiful, low cost cementitious medium that is used with portland cement by the United States Bureau of Reclamation in most current concrete construction.

28855 (CONF-811122—Pt.2, pp 225-232) **Properties of mortars and concrete made with fly ash.** Wesche, K.; Schubert, P. (Aachen Technical Univ., Germany). 1981. Secretariat, Materials Research Society, 102C Materials Research Lab., University Park, PA 16802.

From Annual meeting of the Materials Research Society; Boston, MA, USA (16 Nov 1981).

For about ten years fly ashes from bituminous coal have been used in the Federal Republic of Germany as an admixture to concrete according to the German standard DIN 1045. The principal results of such tests and of other research programs are the following. The greater the fly ash content, the lower the strength at early ages. The strength lag of the mortar or concrete with fly ash diminishes with increasing age. The modulus of elasticity of concretes with fly ash was higher than the modulus of concretes without fly ash. Shrinkage and resistance to freezing and thawing of mortars or concretes made with fly ash were not appreciably different from those without fly ash. A replacement of cement by fly ash to about 50 per cent increases the resistance to sulfate especially when cement with a lower sulfate resistance is used. For en equal reference compressive strength the carbonation behavior of mortars and concretes containing fly ash is generally not appreciably different from the carbonation behavior of concretes made without fly ash.

28856 (CONF-811122—Pt.2, pp 233-242) **Performance characteristics of concretes containing fly ash.** Ramakrishnan, V. (South Dakota School of Mines and Tech., Rapid City, SD); Coyle, W.V.; Brown, J.; Tlustus, P.A.; Venkataramanujam, P. 1981. Secretariat, Materials Research Society, 102C Materials Research Lab., University Park, PA 16802.

From Annual meeting of the Materials Research Society; Boston, MA, USA (16 Nov 1981).

This paper presents the results of a performance evaluation study of concrete containing fly ash. The properties of fly ash concrete have been compared with their corresponding properties of regular concrete. The plastic properties of concrete compared are slump, air content, vebe-time, temperature, unit weight, and setting time of concrete. The hardened concrete properties compared are unit weight, compressive strength, split tensile strength, flexural strength, static modulus of elasticity, dynamic modulus of elasticity, pulse velocity, and absorption coefficient. These properties are compared at four different ages: 3, 7, 28 and 90 days. Durability under rapid freeze-thaw conditions and shrinkage deformations are also discussed. A comparison of the physical properties of fresh concrete on the basis of approximately equal slump and entrained air, has shown the relative ease of placing and finishing concretes containing fly ash. The rate of stiffening is lower for fly ash concrete containing Type I cement. In general fly ash concretes show higher strengths and higher modulus at 90 days than their corresponding regular concretes. However, fly ash concrete has slightly higher drying shrinkage than regular concrete. The strength and elastic modulus relationships are approximately the same for both concretes.

28857 (CONF-811122—Pt.2, pp 244-259) **International aspects of development of the uses of fly ash with cement.** Idorn, G.M. (G.M. Idorn Consultants ApS, Maerum, Denmark). 1981. Secretariat, Materials Research Society, 102C Materials Research Lab., University Park, PA 16802.

From Annual meeting of the Materials Research Society; Boston, MA, USA (16 Nov 1981).

Selected aspects of the development of fly ash uses with cement in Denmark, India, France, Great Britain, Canada, China, Japan, South Africa, Australia, and the USA are described. Important issues of the associated research are identified. The basic reactivity of fly ash/cement systems is discussed as related to origins, compositions, and uses. Research needs for further development are suggested.

28858 (CONF-811122—Pt.2, pp 260-268) **Effects of various types of fly ash on behavior and properties of concrete.** Cain, C.J. (American Fly Ash Co., Des Plaines, IL). 1981. Secretariat, Materials Research Society, 102C Materials Research Lab., University Park, PA 16802.

From Annual meeting of the Materials Research Society; Boston, MA, USA (16 Nov 1981).

The effects of four types of fly ash on the three major categories of concrete (mass, structural and paving, and precast) are discussed. Aspects of concrete production such as economy, workability, strength, and durability are examined in the light of the chemistry and physical characteristics of the four designated types of fly ash and their effects when added to concrete mixes. Class F fly ashes, those from anthracite and bituminous coals, are reported on primarily for their low or high loss on ignition. Class C fly ashes, usually collected from the burning of sub-bituminous and lignite coals, are presented from the perspective of their CaO content and resuting cementitiousness or hydraulicity.

28859 (CONF-811122—Pt.2, pp 269-279) **American and foreign characterization of fly ash for use in concrete.** Manz, O.E. (Univ. of North Dakota, Grand Forks). 1981. Secretariat, Materials Research Society, 102C Materials Research Lab., University Park, PA 16802.

From Annual meeting of the Materials Research Society; Boston, MA, USA (16 Nov 1981).

There are several federal and state specifications being used in the United States involving the use of fly ash in concrete. However, several foreign countries have separate specifications adopted for use by all agencies in the particular country. In the United States, the ASTM has been attempting to resolve the problem of reliable prediction of the contribution of fly ash when substituted for part of the cement in concrete. The widespread use of many different lignite and subbituminous coals has compounded the problem. The characterization of fly ash by reference to the type of coal has been criticized. A review of the various specifications will be presented. The chemical and physical data for several fly ashes will also be presented. Some performance results involving the use of selected fly ashes in concrete will be given. A revised characterization scheme for fly ashes will be discussed.

28860 (CONF-811122—Pt.2, pp 280-288) **Effects of grinding on properties of fly ash cements.** Osbaeck, B. (F.L. Smidth & Co. A/S, Copenhagen, Denmark). 1981. Secretariat, Materials Research Society, 102C Materials Research Lab., University Park, PA 16802.

From Annual meeting of the Materials Research Society; Boston, MA, USA (16 Nov 1981).

The strength development characteristics of a blended cement consisting of portland cement clinker and fly ash (PFA) can be varied within wide limits by expending different amounts of grinding energy on the two constituents, as the hydraulic property of the portland cement and the pozzolanic property of the PFA are both strongly dependent on the fineness of the respective materials. However, strength is also dependent on the initial porosity of the mortar or concrete on which it is measured, and this initial porosity can be influenced, directly or indirectly, through the extent of grinding of the cementing materials. PFA contains pores as an inherent part of its structure (cenospheres and porous carbon particles). The negative effect which these pores can have on the strength of PFA-containing materials can be diminished or eliminated by grinding the PFA. The aspects mentioned are illustrated by results from laboratory experiments.

28861 (CONF-811122—Pt.2, pp 289-295) **Distinction between water reduction and reactivity as the factors influencing flyash performance in concrete.** Barker, W.R. 1981. Secretariat, Materials Research Society, 102C Materials Research Lab., University Park, PA 16802.

From Annual meeting of the Materials Research Society; Boston, MA, USA (16 Nov 1981).

Attempts to evaluate the performance of South African flyashes in blended cements showed poor correlation between the commonly used ash quality criteria of loss on ignition and fineness as related to performance in concrete. Accordingly, a concrete mix test program was devised in which the quality of flyash could be quantified in terms of two parameters, water reduction, and a reactivity index or cementing efficiency of the flyash. Test data using this approach showed the marked difference in performance in concrete between two ashes which were thought to be basically similar. Two main conclusions are drawn from this study: existing specifications for flyash do not define its performance in concrete; and the variation of influence of flyash on the rheology of concrete is inadequately understood.

28862 (CONF-811122—Pt.2, pp 296-305) **Subbituminous fly ash utilization in concrete.** Raba, C.F. Jr. (Raba-Kistner Consultants, Inc., San Antonio, TX); Smith, R.L.; Mearing, M. 1981. Secretariat, Materials Research Society, 102C Materials Research Lab., University Park, PA 16802.

From Annual meeting of the Materials Research Society; Boston, MA, USA (16 Nov 1981).

The use of bituminous fly ash as a mineral admixture for portland cement concrete has been well documented over the years. Subbituminous fly ash, in comparison, has only recently begun to experience widespread utilization in the concrete products market. Therefore, only a limited amount of information on this Class C fly ash has been made available to architects, engineers, ready-mix concrete producers and contractors. This paper presents mix designs using various ash replacement values for combinations of different cements, aggregatesad organic admixtures. The compressive strength of the concrete was found to vary considerably depending on the compatibility of the concrete constituents.

28863 **(CONF-830445—1) Corrosion studies on structural alloys for flue-gas desulfurization systems.** Maiya, P.S. (Argonne National Lab., IL (USA)). 1983. Contract W-31-109-ENG-38. 24p. NTIS, PC A02/MF A01. Order Number DE83010746.

From Corrosion '83 conference; Anaheim, CA, USA (18 Apr 1983).

Several Mo- and Cr-bearing structural alloys of potential applicability in downstream regions of flue-gas desulfurization (FGD) systems have been examined for corrosion in simulated FGD environments at 85°C. To evaluate the importance of hydrogen and chloride ion concentrations, Type 316L stainless steel was exposed for varying times at different pH levels (0.5 to 3.0) and chloride content (0.03 to 5.0 wt % Cl^-). To determine the effects of pH and alloy composition in acid solution that contains a fixed amount of chloride (~ 0.34 wt % Cl^-), a number of alloys were used in which the composition parameter (defined as the sum of Cr and Mo) varied from 19.5 to 33.5 wt %. In all cases, the general corrosion or dissolution as determined from weight loss measurements varied linearly with time. The corrosion rate for the alloys decreased with an increase in pH in a consistent manner regardless of the alloy crystal structure. The composition effects on corrosion rate were most significant at pH = 0.5. The dependence of corrosion rate on pH, chloride ion concentration, and alloy composition is presented in a quantitative manner and the technical as well as technological importance of these results is discussed. 9 figures, 2 tables.

28864 **(CRWR—30) Removal of sulfur dioxide from a hot-gas stream using water-softening sludge.** (Texas Univ., Austin (USA). Center for Research in Water Resources). Oct 1968. 69p. Univ. of Texas at Austin, Center for Research in Water Resources, 10100 Burnet Road, Austin, TX 78758.

The removal of sulfur dioxide from a hot gas stream by scrubbing with water softening lime sludges was evaluated as an alternative to disposal of solid lime sludges. The sulfur dioxide laden gas stream was introduced into the bottom of a laboratory, bench-scale packed tower. As the heated gas stream passed up through the tower, the sulfur dioxide was removed by a lime sludge slurry in a counter-current flow operation. The quantities of lime sludge produced coupled with the expense of treating this sludge in a satisfactory manner with the present technology have prompted research for uses for lime sludges and/or better and less expensive means of disposal. Results indicate lime sludges are effective in removal of SO_2 from hot gas streams. (PSB)

28865 (DOE/MC/16219—1403) Test and evaluation of hot gas cleanup devices. Phase I and II. Task I. Technical progress report, October 1, 1982-December 31, 1982. (Curtiss-Wright Corp., Wood-Ridge, NJ (USA). Power Systems Div.). [nd]. Contract AC21-81MC16219. 56p. (FE—16219-6; CW-WR—81-024.6). NTIS, PC A04/MF A01. Order Number DE83010140.

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This report presents the status of the work performed on a program for the test and evaluation of hot gas cleanup devices for a PFBC combined cycle system. The work was performed during the period October 1, 1982 through December 31, 1982. This is the sixth quarterly report since the start of the program. Work was completed which restored the pressurized fluidized bed (PFB) technology plant at Wood-Ridge, New Jersey, to an operational status. Preliminary designs to incorporate each of three advanced gas cleanup devices into the facility following a first stage low pressure drop inertial type separator were previously completed. The advanced devices are provided by suppliers under separate DOE contracts. They include a ceramic bag filter, an electrostatic precipitator and an electrostatically enhanced inertial separator. Testing of the ceramic bag filter system was completed in May 1982. This report presents the installation and initial testing of the electrostatic precipitator. 3 figures, 3 tables.

28866 (DOE/METC—83-61) Processing needs and methodology for contaminated water streams from synfuels processes. King, C.J.; Lynn, S.; Mohr, D.H. Jr. (California Univ., Berkeley (USA). Dept. of Chemical Engineering). Nov 1981. Contract AC01-81EV10737. 259p. (CONF-8106109—). NTIS, PC A12/MF A01. Order Number DE83010337.

From Workshop on processing needs and methodology for contaminated water streams from synfuels processes; Germantown, MD, USA (24 Jun 1981).

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The workshop identifies needs to be met by processing technology for waste waters from coal gasification, coal liquefaction, and oil shale retorting processes. The purpose of the workshop was to assess the characteristics of waters from these processes, water-management alternatives, treatment or other processing goals, opportunities for recycle and reuse, capabilities and needs for analytical methods, capabilities and costs of current technology, and critical environment-control and cost issues. Because of the limited time available, a decision was made to focus considerations upon the condensate waters from direct coal-liquefaction, low-temperature coal-gasification, and oil-shale retorting processes. These are in most respects the most contaminated streams and have large flow volumes. Sections II through VII of this report cover these critical issues, and represent summaries of the workshop discussions. In addition, summary status reports of current work are included in this document. (DMC)

28867 (EUR—7185-e) The purification of coke-oven effluents. Rosello, A. (Commission of the European Communities, Luxembourg). 1981. 120p. (In Italian). Commission of the European Communities, Luxembourg.

The report describes pilot-scale experiments with different effluent treatments, to see what were the technical requirements for reducing pollution to the lowest levels permitted in various EEC countries. The treatments involved are: (1) biological, with (a) activated sludge and (b) biodiscs (a kind of rotating biological filter), and (2) chemicophysical with active carbon. The report concludes: (1) that activated sludge and biodiscs should be used in conjunction, since the former does not reduce all pollutants and the second method is more flexible to use: (2) that active carbon only reduces phenols with significant success, but that it has several technical advantages over the biological systems. Comparative investment and total costs of the three systems are given, and detailed results of the experiments fully tabulated.

28868 (P—82/13) Report to the IEA AFBC technical meeting at Petten, Netherlands, May 1982: TNO's environmental program on fluidized bed combustion. van Duin, P.J. (Nederlandse Centrale Organisatie voor Toegepast Natuurwetenschappelijk Onderzoek, The Hague). 1982. vp. (CONF-8205153—). TNO, PO Box 217, Delft, Netherlands.

From IEA/AFBC technical meeting; Petten, Netherlands (1 May 1982).

TNO carries out an environmental research program on fluidized bed combustion of coal. Tests are executed with a 4 MW experimental atmospheric fluid bed boiler. To reduce the emission of sulfur dioxide, coal is mixed with limestone. The limestone turned out to be used partially, due to the formation of a calcium sulfate layer on the surface of the limestone particles. This conclusion was confirmed by X-ray mapping. Fly ash was investigated for harmful properties. When collected at low temperatures fly ash showed substantial genotoxicity.

28869 Control by alkaline neutralization of trace elements in acidic coal cleaning waste leachates. Wangen, L.E.; Williams, J.M. (Los Alamos National Lab., NM). *Journal - Water Pollution Control Federation;* 54: No. 9, 1302-1310(Sep 1982).

In addition to acid, aluminum, iron, and manganese, a number of trace inorganic chemical species such as As, Cd, Co, Cr, Cu, F, Ni, and Zn are present in leachates from mineral by-products of coal cleaning - and at excessive concentrations in comparison to water quality criteria. The thrust of this article is to present results of these laboratory investigations and to compare them with concentrations predicted by a chemical equilibrium model as a function of pH. In addition, the speciation of components and controlling solids as predicted by the chemical equilibrium model is presented. The chemical equilibrium model used accounts for solubility of solid phases but not for secondary mechanisms such as sorption of trace species on solids or coprecipitation. (JMT)

28870 Estimation of activity coefficients in concentrated sulfite-sulfate solutions. Rosenblatt, G.M. (Lawrence Berkeley Lab., CA). *AIChE (American Institute of Chemical Engineers) Journal;* 27: No. 4, 619-626(Jul 1981). Contract W-7405-ENG-48.

The electrolyte theory of Pitzer and coworkers is used to estimate geometric mean-ion activity coefficients in strong electrolyte solutions at 25 to 55°C. By using Pitzer's equations with ion-pair parameters estimated in this paper, activity coefficients can be calculated to moderately high ionic strengths in aqueous mixtures containing the following ions: Na^+, K^+, Mg^{2+}, Ca^{2+}, Cl^-, ClO_3^-, ClO_4^-, HCO_3^-, HSO_3^-, CO_3^{2-}, SO_4^{2-}, SO_3^{2-}, and $S_2O_3^{2-}$. Mixtures containing these ions are present in $CaO/CaSO_4$ flue gas desulfurization units and in laboratory experiments aimed at understanding the chemistry occurring in such units. The computed activity coefficients are relatively insensitive to the values of the estimated quantities. The basis of the estimates, as well as their effect on calculated activity coefficients, is discussed. It is concluded that activity coefficients are estimated with an accuracy of +-25% or better.

28871 Comparison of three solid waste batch leach testing methods and a column leach test method. Jackson, K.; Benedik, J.; Jackson, L. (US DOE, Laramie, WY, USA). *American Society for Testing and Materials, Special Technical Publication;* 83-98(1981). (CONF-810185—).

From ASTM conference on hazard solid waste test; Ft. Lauderdale, FL, USA (14 Jan 1981).

A study was conducted on various extraction techniques for solid wastes. The batch versus column extraction methods were assessed. A standard fly ash material was leached from one hour to 96 hours. The leachates were analyzed by spectrophotometers for selenium, chromium, arsenic, lead and cadmium. The results show that the batch test can be improved by increasing the liquid-to-solid ratio, and that the leaching time may be decreased.

28872 Stabilization of fine-coal-refuse slurry through use of cement-type additives. Wen, W.W. (Dept. of Energy, Pittsburgh, PA); Hutchinson, D.W.; Terchick, A.A.; Anderson, J.C. *Transactions of the American Institute of Mining Engineers;* 270: 1831-1835(1979).

It is estimated that approximately 3% of the raw coal processed today in coal preparation plants throughout the nation will ultimately report to slurry-tailing disposal. The usual disposal method is to pump refuse slurry containing -48 mesh (300 μm) refuse into dams or impoundments constructed of coarse refuse. The failure of an impoundment at Buffalo Creek, Saunders, WV resulted in an evaluation of refuse disposal methods by various regulatory agencies as well as coal producers. The result of this evaluation was the promulgation of federal regulations dealing with the construction, operation, and final abandonment of coal refuse disposal area. As a consequence of these regulations, the use of the landfill/impoundment method of disposal became in some cases economically unfeasible or technically impossible. US Steel has studied a number of alternative methods of refuse disposal. During an investigation of mechanical dewatering with a pressure filter, portland cement was added to the slurry to solidify the filter cake. Because of the success of the cement addition, it was decided to study the stabilization of fine coal refuse slurry through use of cement-type additives. The goal of the investigation is to develop a process that will use cement-type additives to solidify the refuse slurry into a form that can be handled and stacked with the coarse refuse, thus eliminating the need for slurry impoundments.

0109 Environmental Aspects

REFER ALSO TO CITATION(S) 28892, 28921, 28946, 28949, 28950, 28985, 30357

28873 (EPS—5-AR-82-3) Environmental quality in Sydney and northeast industrial Cape Breton, Nova Scotia. Hildebrand, L.P. (Environment Canada, Dartmouth, Nova Scotia. Environmental Protection Service). Jan 1982. 89p. Environment Canada, Dartmouth, Nova Scotia. Environment Protection Service.

The report discusses the levels of conventional atmospheric pollutants, defines trends in concentrations and discusses source contributions. Aqueous effluent sources in the Sydney area are described and the effluents are characterized. Fish plants and coal mining operations in the Sydney - Glace Bay area are identified and their impact on the environment is described. A summary of the findings of water quality surveys and biological surveys in Sydney Harbour is given. Solid waste disposal practices are briefly outlined. The report concludes by identifying areas where further environmental quality work is desirable. (60 refs.)

28874 (ORNL/TM—8552) Environmental evaluation of the University of Minnesota-Duluth coal gasifier. Cushman, R.M.; Suter, G.W. II; Brown, D.K.; Edwards, N.T.; Griest, W.H.; Stewart, A.J.; Strand, R.H. (Oak Ridge National Lab., TN (USA)). Mar 1983. Contract W-7405-ENG-26. 36p. NTIS, PC A03/MF A01. Order Number DE83010462.

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Final results are reported for the environmental evaluation portion of a comprehensive monitoring and testing program focused on a small Foster-Wheeler/Stoic coal gasifier at the University of Minnesota-Duluth (UMD). Leachates of solid wastes (bottom ash and cyclone separator char) from three heating seasons of operation of the UMD gasifier were tested chemically and toxicologically. These tests indicate that the solids would not be considered toxic-hazardous according to the current interpretation of the Resource Conservation and Recovery Act (RCRA) of 1976. This determination does not, however, ensure that the solids would be environmentally benign in all respects. In terms of leachate trace element composition, solid wastes from the UMD gasifier are generally similar to those from other low-Btu gasifiers. Leachates from a variety of industrial and municipal solid wastes generally equal or exceed the UMD solid waste leachates in trace element concentrations and toxicity. Atmospheric monitoring indicated that air quality is good in the vicinity of the UMD steam plant and is not greatly affected by gasifier operation.

28875 Health and environmental studies of coal gasification process streams and effluents. Reilly, C.A. Jr.; Boparai, A.S.; Bourne, S. (Argonne National Lab., IL). pp 282-292 of Symposium proceedings: environmental aspects of fuel conversion technology. VI. A symposium on coal-based synfuels. Ayer, F.A.; Jones, N.S. (comps.). Research Triangle Park, NC; Research Triangle Institute (1981).

The results of this study on the toxicological and chemical characterization of two high-Btu coal gasification pilot plants demonstrate that while toxicants are present, they are a minor component of the process streams. The toxicity is largely confined to the nonvolatile components of the by-produce tars and oils. These materials will not leave the commercial plant site because they are ultimately consumed in the process. On-site emissions can be controlled through appropriate control technology. Occupational exposures can be minimized through effective industrial hygiene procedures. These considerations allow the general assessment that no apparent serious health or environmental problems are associated with coal gasification. 6 tables.

0110 Reserves And Exploration

REFER ALSO TO CITATION(S) 28884

28876 (CONF-820273—, pp 11p, Paper 3) **Alaska's coal resources.** Webber, C.R. (Alaska Dept. of Commerce and Economic Development, Juneau). 1982. Resource Development Council for Alaska, 444 West 7th Ave., Box 516, Anchorage, AK $30.00.

From 2. Alaska coal marketing conference; Anchorage, AK, USA (18 Feb 1982).

Alaska has coal, and the capability of competing in an international market. But developing our coal deposits and creating an infrastructure to support that industry may only be a beginning. The ultimate emergence of Alaska, as not only a producer of raw resources but as a manufacturer of goods, is not only possible but probable. The state can finally break its historical dependence on federally subsidized projects, and most recently, its singular dependence on petroleum revenues. The participation of the state in creating a facility that would accommodate future export expansion would have two very beneficial effects. It would consolidate many potential port requirements in a single location. As there are a few good port sites on cook inlet, this would maximize the utilization of the favorable granite point site, and minimize the environmental impact that would occur if project-specific facilities were to be created in a number of locations. Additionally, the coordinated development of a port, railroad and highway network to the western shore of cook inlet would be the catalyst for attracting secondary industries to a location that could provide the spectrum of raw resources, inexpensive and abundant energy, and ready access to a rapidly developing Pacific Rim market.

28877 (CONF-820273—, pp 4p, Paper 19) **Joint venture opportunities in Alaskan coal development.** Klett, F. (Cook Inlet Region, Inc., Anchorage, AK). 1982. Resource Development Council for Alaska, 444 West 7th Ave., Box 516, Anchorage, AK $30.00.

From 2. Alaska coal marketing conference; Anchorage, AK, USA (18 Feb 1982).

My comments today will cover two fundamental types of joint venture opportunities; first, on the private enterprise activities associated with the exploration, development and marketing of Alaskan coal; and the second and major topic will be public/private joint ventures in the context of project development, and then in the context of long-term land management responsibilities. As owner of almost one million acres scattered among the Beluga, Kenai and Mat Valley areas we at Cook Inlet Region are generally aware of the coal potential of our Region. We, therefore, are very much interested in joint exploration and development partners to more fully identify the coal reserves in the Cook Inlet Region. However, the corner stone of Cook Inlet Region's natural resource policy is that our partner or partners must have the strength and staying power required to bring coal to actual development. Our studies indicate that coal can be developed in Alaska but that it will be neither easy nor cheap. And it is likely that the market will be a

competitive one. We are not interested in just identifying coal reserves; we want to develop coal reserves - and it is clear this will take both substantial financial resources and management commitment. We are interested in forming relationships with resource companies - whether foreign or domestic - that share this view. The development of this coal will provide many opportunities for joint ventures.

28878 (LA—9479-PR, pp 142-144) **Piceance Basin mule deer study.** Garrott, R.A.; White, G.C. Oct 1982. NTIS, PC A08/MF A01.

In Los Alamos Life Sciences Division's biomedical and environmental research programs. Progress report, January-December 1981.

To study the potential impact of a full-field development of oil shale resources in the Piceance Basin, mule deer in the area were trapped and radio collared. The deer's migrational pathways; winter, summer, and spring migrational movements; and mortality were studied. (DLS)

28879 (USGS-OFR—80-2) **Deep-coal-bed methane potential of the San Juan River coal region, southwestern Colorado.** Kelso, B.S.; Goolsby, S.M.; Tremain, C.M. (Colorado Geological Survey, Denver (USA)). 1980. Contract FG21-80MC14256. 182p. NTIS, PC A09/MF A01. Order Number DE83010377.

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The deepest, highest ranking and probably gassiest coals in the San Juan River coal region of southwestern Colorado are found in the 100 mile (mi) wide San Juan Basin of Colorado and New Mexico. The thickest and most continuous coal beds in the basin are found in the Cretaceous Fruitland Formation. Logs from 231 petroleum exploration drill holes were used to produce the following: a Fruitland Formation isopach, a Pictured Cliffs structure map, Fruitland Formation net coal and net sand isopachs, and Fruitland coal percentage and sand percentage maps. Of the 231 holes, 8 produced natural gas from sandstones in coal bearing zones, 5 were production tested in mixed sandstone and coal intervals (one well had an initial production of 1.6 MMCFGPD), and 5 were drill stem tested in coal bearing zones (one flowed 1 MMCFG in 35 min). The authors calculate 19.7 billion tons of coal are present in the study area. The coals are ranked high-volatile B (hvB) and high-volatile A (hvA) with local upgrading to medium-volatile (mv). Comparing gas contents of Cretaceous Raton Mesa coals to San Juan Basin coals, a gas potential ranging from 72 cubic feet/ton (cu ft/ton) to 514 cu ft/ton exists. The authors estimate a gas resource in the study area ranging from 1.4 to 10.0 trillion cubic feet. The data indicates that gas is present in the coals of the study area. This gas has been produced from sandstones adjacent to the coals and possibly from the coals themselves. Therefore, it might pay to test the Fruitland coals encountered while drilling for deeper targets. With the right economic factors and development of completion techniques for coal bed methane, this gas resource may prove to be important. Data gained from vitrinite reflectance of cuttings, desorption of cuttings, and desorption of conventional cores continue to support the existing evidence that coal bed gas is being generated and trapped in the deeper portion of the San Juan Basin.

0120 Mining

REFER ALSO TO CITATION(S) 28873, 28927, 28971, 28974, 28976, 28979, 28985

28880 (ACIRL-PR—81-3) **Rock mechanics design criteria for longwall mining at Angus Place colliery.** Schaller, S.; Hebblewhite, B.K. (Australian Coal Industry Research Labs. Ltd., North Ryde). 1981. 82p. Australian Coal Industry Research Labs. Ltd., North Ryde.

Field research at Angus Place colliery has been conducted by Australian Coal Industry Research Laboratories Ltd., to assess the underground conditions and geochemical strata behaviour associated with longwall extraction. Angus Place is the first colliery to introduce longwall mining in the Western coalfields of New South Wales. The investigations have included underground coring of roof and floor strata and subsequent rock property determinations, monitoring of convergence, roof and rib deformations using borehole extensometers from the gate roads, stress changes on chain pillars, face support loads, plus surface subsidence above the longwall panel. Results have been analysed to define the strata response to longwalling under shallow conditions (27 m) and therefore provide information to assist in future longwall planning.

28881 (ACIRL-PR—82-1) **Results of the first trial single entry development at Ellalong Colliery.** Wallman, D. (Australian Coal Industry Research Labs. Ltd., North Ryde). Dec 1981. 43p. Australian Coal Industry Research Labs. Ltd., North Ryde.

A trial single entry development is being conducted using a DOSCO In Seam Miner at Ellalong Colliery, New South Wales. Results are discussed. The first trial single entry was driven to a length of 423 m. A stable roadway was produced at acceptable advance rates under safe working conditions. The In Seam Miner performed well and only minor maintenance problems were encountered. (4 refs.)

28882 (CONF-820273—, pp 4p, Paper 8) **Manpower considerations for the development and operation of large scale surface coal mines.** Eidlin, M.B. 1982. Resource Development Council for Alaska, 444 West 7th Ave., Box 516, Anchorage, AK $30.00.

From 2. Alaska coal marketing conference; Anchorage, AK, USA (18 Feb 1982).

Alaska will face two challenges associated with the development of its coal resources. First, the state must respond to the relatively short term demand for construction forces to build the mines. The second, and most important challenge, will be to provide a skilled, stable workforce to enable its mines to compete in the world marketplace. This paper focuses on the labor requirements for the development and operation of a large scale (6 million - 12 million to per year) surface coal mine. The information was obtained by NERCO, Inc. and its subsidiaries in the process of developing and operating surface coal mines in the states of Wyoming and Montana. The information relating to development was obtained during the construction of NERCO's Spring Creek Mine which was completed and placed in production in December 1980. While each mine project is unique, the data presented here should serve as a guide in estimating the labor requirements for both of the projects currently being contemplated for the Beluga coal field. The Spring Creek Mine is a 7 million ton per year surface coal mine located in southeastern Montana. The construction phase lasted approximately 20 months beginning in April 1979. The Project included construction of approximately 4 miles of 34.5 kV power line to provide temporary construction power, approximately 8 miles of 230 kV powerline for permanent power, approximately 10 miles of railroad spur track and loading loop, a 70,000 ft^2 administrative office/warehouse/maintenance shop complex, a 3100 to 4000 ton per hour coal crushing, conveying and load-out system; a 45,000 ton coal storage barn with automated stacker-reclaimer system; and relocation of approximately 6 miles of state secondary highway. In addition to these permanent facilities, a 52 yd^3 Page 757 walking dragline and two P & H 2100 BLE mining shovels were erected during the construction phase.

28883 (CONF-820273—, pp 6p, Paper 9) **Alaska-environmental policies related to coal mining.** Katz, J. (Alaska Dept. of Natural Resources, Juneau). 1982. Resource Development Council for Alaska, 444 West 7th Ave., Box 516, Anchorage, AK $30.00.

From 2. Alaska coal marketing conference; Anchorage, AK, USA (18 Feb 1982).

The most abundant coal resource is located on federal lands in the National Petroleum Reserve Alaska. This resource ranges in excess of two or three trillion tons. Right now it is off limits to development, although there is legislation pending in Congress that would at least open portions of the reserve to local use. A second important coal resource is located at Healy, Alaska. It is the site of the Usibelli Mine which is located on state leases. The third important area is the Beluga area which will clearly be the site of the next important coal development in the state. A fourth area is the Matanuska Valley. There are a number of pending coal permits in that area now and the likelihood of success is very much dependent upon the overburden which varies from place to place in the

valley. Alaska has a relatively short period of time in which to create a climate for coal development and which to establish the rules for that development. This perception is confirmed by representatives from Taiwan, South Korea, Japan and other places on the Pacific Rim with whom I've met from time to time. They expressed a real interest in Alaska coal, principally because of the transportation factor. But they do have access to coal from other places, including Australia and some of the other lower 48 western states. They would like very much if they can to diversify their supplies and that is one of the reasons for their interest in Alaska coal.

28884 (CONF-820273—, pp 6p, Paper 11) **Alaskan coal projects and development plans.** 1982. Resource Development Council for Alaska, 444 West 7th Ave., Box 516, Anchorage, AK $30.00.

From 2. Alaska coal marketing conference; Anchorage, AK, USA (18 Feb 1982).

The Usibelli mine is the only large producing mine in Alaska with an annual production of 800,000 tons. Three other companies with leases and completed exploration efforts have large developed resources are making marketing effects in Pacific Rim countries and have sent some test shipments. Supplying coal that can economically compete against coal from other sources will determine Alaska's coal share of the marketplace. Competition for market share will be intense from both suppliers of the continental United States and other exporting countries. It should be stressed that the future market for Alaskan coal will be demand driven - highly dependent on quality requirements and supply diversification desires of importing nations, its cost competitiveness and the state's willingness to assist infrastructure development. The costs of developing a mine or mining complex, transportation facilities to the coast and port facilities are all interwoven into the economics of delivering energy to the marketplace. Alaska's reasonably favorable geographic position with respect to Pacific Rim markets and the proximity of the Beluga-Yentna region coal fields to ocean transportation improves the competitiveness of this coal on a delivered cost basis compared to coal from the lower 48 and other exporting countries. However, the low heating value of Alaskan coal may inhibit near term demand. Coal burning facilities which can efficiently use these high quality sub-bituminous coals are not in extensive use in potential importing countries. The time and capital needed to design and build these facilities suggests that large volume exports from Alaska will not take place until sometime in the future.

28885 (CONF-820273—, pp 4p, Paper 18) **Joint venture opportunities for the development of Alaska coal resources.** Drage, L. (Chugach Natives, Inc., Anchorage, AK). 1982. Resource Development Council for Alaska, 444 West 7th Ave., Box 516, Anchorage, AK $30.00.

From 2. Alaska coal marketing conference; Anchorage, AK, USA (18 Feb 1982).

28886 (CONF-820273—, pp 7p, Paper 24) **Alaska's competitors in the Pacific steam coal market.** Mann, C.E. (Dames and Moore, Anchorage, AK). 1982. Resource Development Council for Alaska, 444 West 7th Ave., Box 516, Anchorage, AK $30.00.

From 2. Alaska coal marketing conference; Anchorage, AK, USA (18 Feb 1982).

The competitors of Alaskan coal must be discussed in terms of the markets which are primarily in Japan, Korea, and Taiwan. Therefore, the countries which will compete for a market in Japan, Korea, and Taiwan are the principal competitors of Alaskan coal. The key factors of these markets are their overall size, the quality requirements of the principal consumers, and the purchasing strategies and objectives of these consumers. By the early 1990's nearly 70 million tons per year of steam coal will be purchased by these three principal importing countries, rising to 150 to 200 million tons per year by 2000. The quality requirements of the major importers are based on their decisions about the quality of coals likely to be available to them in the world marketplace and the economic and physical constraints on the range of coal they can use. In general, current quality requirements limit the markets to coals with a calorific value greater than about 11,000 Btu per pound. Until a decision is made to specifically design powerplants or other facilities to use subbituminous coal such as the Alaska coal, it is not likely to be marketable. Even when importing countries are willing to review the Alaskan coal it will have to compete in terms of economy of use against bituminous coals from other sources. The economic purchasing objectives and strategies of the major importers include not only an emphasis on lowest price per million Btu or per kilowatt-hour of electricity produced, but also consideration of security of supply and flexibility or ease of use; these factors may not be readily translated into dollar figures. Overall, the consumers, particularly the Japanese, place a relatively heavy emphasis on stable and secure supplies.

28887 (DOE/FE/00016—T6) **Evaluate fundamental approaches to longwall dust control. Phase II report.** Babbitt, C.; Bartlett, P.; Kelly, J.; Ludlow, J.; Mangolds, A.; Rajan, S.; Ruggieri, S.; Varga, E. (Foster-Miller, Inc., Waltham, MA (USA)). 31 Mar 1983. Contract AI01-81FE00016. 188p. NTIS, PC A09/MF A01. Order Number DE83010356.

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Increased levels of coal production on longwalls has brought with it higher levels of dust generation. Most United States longwalls have diffuculty complying with federal dust standards which are much stricter than those imposed in Europe. This program offers the mining industry the opportunity to sort out and share assessments of the dust control techniques in use today and those proposed for the future. This objective is being achieved through laboratory and field evaluations of both available and proposed dust control practices using innovative sampling procedures and state-of-the-art respirable dust monitors and instrumentation. In this manner, the effectiveness or lack of effectiveness of longwall dust control techniques can be quantified, thereby providing the information necessary for proper application of these techniques. This program is investigating nine different dust control techniques. This report documents the Phase II effort on each of the subprograms: Passive Barriers/Spray Air Movers for Dust Control at the Shearer; Practical Aspects of Deep Cutting; Stage Loader Dust Control; Longwall Automation Technology (remote control); Longwall Application of Ventilation Curtains; Reversed Drum Rotation; Reduction of Shield Generated Dust; Air Canopies for Longwalls; and Mining Practices. Each of these dust control methods was investigated, usually at a few or several mines, and the results were often supplemented by discussion with manufacturers and special sampling tests.

28888 (DOE/PC/30123—T7) **Methane modeling: predicting the inflow of methane gas into coal mines. Quarterly technical progress report, October 1, 1982-December 31, 1982.** Boyer, C.M. II; Hoysan, P.M.; Pavone, A.M.; Schwerer, F.C. (United States Steel Corp., Monroeville, PA. Research Lab.). 1982. Contract AC22-80PC30123. 229p. NTIS, PC A11. Order Number DE83010281.

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Maintenance and laboratory calibrations were obtained for automatic recording methanometers for use during in-mine tests. Speecifications and quotations have been obtained for battery operated versions of the automatic recording methanometers for monitoring in the tailgate region of the longwall operation. Due to mine closings, meetings with mine operators to discuss in-mine testing and to observe the mining section to be monitored have been delayed until February 1983. Assuming a resumption of coal production, actual in-mine tests are tentatively scheduled for March, 1983. Development and testing of software modules for a general two-dimensional model has continued with good progress. The major work emphasis is on the efficient computer execution of the numerical algorithms. Preliminary simulation test runs of an isolated, unstimulated well in an isotropic, homogeneous coalbed have been made. Work has been initiated on incorporating an infinite conductivity fracture in the simulation. Graphical representation of the data generated from the two-dimensional model will be produced and verified. A request was initiated for a no-cost, six-minths extension; this request has subsequently been approved. There is no change in the contract objectives or technical approach, and the project is on target with respect to expenditures.

28889 **(ECE/COAL—67) Technical advances in the mechanization and automation of face work in thin (less than 1.2 m), gently sloping (0.35 degrees) seams; choice of methods of working such seams according to geological, technical and economic conditions.** (United Nations, New York (USA)). 18 Oct 1982. 12p. United Nations, New York, NY.

A report based on information submitted by Belgium, Federal Republic of Germany, France, Poland, Czechoslovakia, Ukrainian SSR, and USSR. Techniques and methods for the integrated mechanization and automation of coal face operations in these countries are described. A combination of hydraulic supports, a narrow-web cutter-loader or plough and a non-sectional scraper conveyor appears to be the most favoured arrangement. Since 1970, both the USSR and the Ukrainian SSR have greatly increased the number of fully mechanized mining operations in thin seams.

28890 **(ECE/COAL—69) Drivage, development and support of roadways and faces in deep mines - 1,000 metres and more and consequently in more difficult mining, geological and atmospheric conditions.** (United Nations, New York (USA)). 19 Oct 1982. 24p. United Nations, New York, NY.

This article describes the results of a survey of the various approaches to mining deep underground adopted by several European countries. Coal deposits below 1,000 metres are described, both current and proposed mining operations at this depth are outlined. The strata pressure and rock mechanics associated with such depths are assessed with the aid of graphs. The ventilation of deep mines with working temperatures of 40-46 C is discussed, methods of shafts construction and roadway drivage are considered. The current technology available for coal extraction of this kind is reviewed. (7 refs.)

28891 **(ECE/COAL—70) Concentration indices in the European coal industries.** (United Nations, New York (USA)). 19 Oct 1982. 18p. United Nations, New York, NY.

This article presents an analysis of variations over time in the concentration indices for underground mines from 1965-1980. The analysis is based upon information received from Federal Republic of Germany, France, Hungary, Poland, Czechoslovakia, USSR and Belgium. Statistics are presented for the number of collieries, the average daily output per colliery, and the variations in output over time. The largest category, mechanised longwall faces, is considered in detail using the average length of the face; the weighted average of seam thickness; the average rate of advance; the average daily (net) output per face; and the average number of faces with an average daily production of 1,000 tonnes or more.

28892 **(ECE/COAL—71) Exchange of experience in coal extraction under buildings and industrial plants.** (United Nations, New York (USA)). 19 Oct 1982. vp. United Nations, New York, NY.

Contains four papers presented by Belgium, Poland, United Kingdom and Yugoslavia respectively. Belgium has no original method for calculating ground deformation owing to mining and monitoring is restricted to vertical displacement. Poland, United Kingdom and Yugoslavia all undertake large-scale mining operations under built up areas. The measures adopted by these countries to safeguard surface structures against surface deformation are described. Whilst Poland and Yugoslavia make extensive use of safety pillars, the United Kingdom uses only a relatively small number of pillars of support, relying on flexibility of design in supports and roadways to prevent subsidence.

28893 **(ECE/COAL—73) Coal-getting systems not requiring the presence of men at the face at all times and methods of working coal which do not require the presence of man underground.** (United Nations, New York (USA)). 10 Nov 1982. 8p. United Nations, New York, NY.

Discusses the automation of underground coal mining operations. The discussion is mainly confined to methods and techniques used within the USSR, although reference is made to work in Poland and the United Kingdom. Much of the coal produced by the USSR is mined using integrated mechanization at longwall faces and hydraulic supports are often employed. However, mechanization of short-wall faces and room and pillar mining is considered. The use of robots is discussed, and the current state of underground robot technology is assessed. Alternative, 'unconventional' methods of coal extraction are mentioned, such as the underground gasification of coal and the breaking of coal from seams by chemical methods.

28894 **(EUR—6941-e) Development of new and improved types of roadway support.** (Commission of the European Communities, Luxembourg). 1981. 341p. Commission of the European Communities, Luxembourg.

This report on roadway supports is divided into eight sections covering: introduction, concrete encased beams, pre-assembled panels, roadway drivage and support, grout filled envelopes, glass reinforced concrete panels, Selby project and shotcrete roadway lining. The use of concrete encased beams was found to be impractical, and the pre-assembled panels were expensive when compared to arches and did not have their flexibility. Grout filled envelopes had improved arch performance, and the use of glass reinforced concrete panels for roadway lagging was feasible but not economical at present. A trial of the dry process of shotcreting proved to be effective in preventing or controlling spontaneous combustion.

28895 **(EUR—6946-d) Integrated mechanization of winning, supporting and stowing in thick seams.** (Commission of the European Communities, Luxembourg). 1981. 174p. (In German). Commission of the European Communities, Luxembourg.

The aim of the projects was the integration of machinery at the face in thick seams. A new winning method was developed involving combined cutting and breaking, by backcutting the face with picks mounted around a disc and breaking the remaining coal fillet with breaking tools. This technique was developed so that the face could be cut at a specific angle and to keep the coal as coarse as possible. Shield supports were also developed to be used with this technique.

28896 **(EUR—6951-e) Continuous mining system: stone and stone/coal headings.** (Commission of the European Communities, Luxembourg). 1981. 68p. Commission of the European Communities, Luxembourg.

This paper describes work undertaken to provide both recorded data and visual observations upon which the design of tunneling machines for excavating and supporting both circular section and arch section roadways can be based. The cutting assembly devised at MRDE uses tungsten carbide tipped tools, and is capable of cutting about 98% of the strata likely to be encountered in UK coal mines.

28897 **(EUR—7176-e) Ideal requirements of packs.** (Commission of the European Communities, Luxembourg). 1981. 162p. Commission of the European Communities, Luxembourg.

The number of non-manual packing systems in use in British coal mines has actually decreased since 1972. Over the same period there has been a small but steady increase in the number of systems putting on denser stronger packs, either by pump packing, anhydrite or pneumatic stowing. Though still a small percentage of the total, the high utilisation rate of such systems is an indication of appreciation of the benefits to be achieved in terms of ventilation and control of spontaneous combustion in addition to roadway stability. Examination of the characteristics and performance of packs, particularly monolithic types both underground and by physical modelling, has led to a closer definition of the short and long term contribution of the pack to the maintenance of acceptable conditions in gateroads. This has led to a hard look at the contents of packs and the development of new and improved materials to ensure that the optimum performance is achieved from the resulting pack.

28898 **(ORAU—210) Causes and effects of escalating prices for deep-mine machinery.** Baker, J.G. (Oak Ridge Associated Universities, Inc., TN (USA)). Feb 1983. Contract AC05-76OR00033. 48p. NTIS, PC A03/MF A01. Order Number DE83010354.

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This report examines the issue of escalating deep-coal-mine machinery prices in the 1970s. Producer price trends, mining investment costs, mine asset values, and discussions with used-equipment brokers all indicated that deep-mining-equipment prices escalated faster than miner wages and general prices during the 1970s. Causes of this price escalation include increased demand for mining equipment, regulation, general price inflation, and overcapitalization. Consequences of higher deep mine equipment prices were also examined. These consequences include changes in the capital-labor mix, the output per worker, coal supply, and the cost of production. Because of changes in coal price, regulation, and marketing arrangements in the 1970s, the effect of machinery price increases was difficult to examine, but it appears small. Also examined is the effect on mine cash flow of the Accelerated Cost Recovery System of the 1981 Economic Recovery Tax Act. This law changes mine depreciation patterns and will have a substantial impact on coal-mine rate of return.

28899 **Corner-cutting mining assembly.** Bradley, J.A. US Patent Application 6-279,391. 1 Jul 1981. 11p. Contract AC01-78ET10041.

This invention resulted from a contract with the United States Department of Energy and relates to a mining tool. More particularly, the invention relates to an assembly capable of drilling a hole having a square cross-sectional shape with radiused corners. In mining operations in which conventional auger-type drills are used to form a series of parallel, cylindrical holes in a coal seam, a large amount of coal remains in place in the seam because the shape of the holes leaves thick webs between the holes. A higher percentage of coal can be mined from a seam by a means capable of drilling holes having a substantially square cross section. It is an object of this invention to provide an improved mining apparatus by means of which the amount of coal recovered from a seam deposit can be increased. Another object of the invention is to provide a drilling assembly which cuts corners in a hole having a circular cross section. These objects and other advantages are attained by a preferred embodiment of the invention.

28900 **Analysis of the stability of a highwall in an open cut strip coal mine.** Cox, R.H.T. Mount Waverley, Australia; Commonwealth Scientific and Industrial Research Organization (1981). vp.

Ground deformation and moisture measuring instruments were installed in the highwall close to the open cut of Goonyella Mine in Central Queensland. The purpose was to monitor changes that would occur as a result of mining, overburden and coal blasting, and possibly highwall failures. The boreholes were logged and triaxial and shear tests performed on the cored samples. The sensitivity of the sample strengths was related to moisture content. During the course of this investigation two highwall failures occurred in close proximity to the instruments. The first occurred towards the end of October, 1977 and comprised a 450 m long section of the highwall just north of the instruments. The second failure extended about 170 m south from the first but included material only a few metres from the edge of the bench. The outermost instruments were severed in this case. The instrument response is analysed and a mechanism for failure suggested. This is backed up with a parametric study involving the inclination and friction characteristics of the failure boundaries. The analytical model based on the method of slices, has been expanded to model dynamic behaviour after failure initiation. This approach, based on the energy balance of the moving system, demonstrates the self-stabilization can occur after significant displacement.

28901 **Pre-tensioning rock bolts.** Fuller, P.G.; Cadby, G.W. Mount Waverley, Australia; Commonwealth Scientific and Industrial Research Organization (1981). vp.

A graphical format has been used to express the relation between pretension developed in a commonly used rock bolt and applied torque and friction at the thread and collar plate. Pre-tension is sensitive to the coefficient of friction at both the thread and collar. The dependence of these friction coefficients on lubrication and the friction on the moving surfaces of the thread and collar are discussed. Tests on a new method of reducing friction at the collar show that the collar friction coefficient is much less than that applicable to normal collar conditions. Increasing the contact angle between the nut and collar leads to an increase in collar friction and consequent reduction in bolt pre-tension. A series of charts appended to the report enable quick assessment of the pre-tension developed in a rock bolt at a particular applied torque and afford a check that the bolts are not over-stressed during tensioning.

28902 **Powered hand tools.** Burton-on-Trent, England; Mining Research and Development Establishment (1981). 10p.

The bulletin gives details of the range of portable hand-held hydraulic tools for use from the chock line supply. Two sizes of impact wrench, a saw and a drill are now available from the listed manufacturer. The development contract has been extended to cover the production of a nut splitter, chipping hammer, nibbler, and hoist. All these tools will help in both installation, salvage, and maintenance operations, thus saving manpower, time, and money.

28903 **Microseismic monitoring at 53 level, West No. 2 Mine, Collinsville - a feasibility study.** McKavanagh, B.M. Mount Waverley, Australia; Commonwealth Scientific and Industrial Research Organization (1980). vp.

Microseismic noise was monitored during negotiation of an over-thrust fault at Bowen No. 2 Mine Collinsville, Queensland. The low-level of noise recorded suggests that the technique used may not be sensitive enough for the mining conditions. No outbursts occurred. A significant increase in noise level was recorded following a shot firing. Suggestions are made for extension of this work.

28904 **Sensitivity and back-analysis of translational failures in Goonyella highwalls.** Gonano, L.P. Mount Waverley, Australia; Commonwealth Scientific and Industrial Research Organization (1980). vp.

A limiting equilibrium method of analysis was applied to study the sensitivity of stability to various factors and to the back-analysis of recent failures in the Goonyella mine. The analyses were specifically tailored to suit mine conditions encountered. In both practical and theoretical terms, stability is found to be most affected by variations in the orientation of the failure plane. The relative frequency of occurrence of models of failure are discussed. Within the zone of failure significant disruption of material compared to overburden remote from the mine is indicated. There is considerable variability in the calculated values of failure plane strength. An approach to enable prediction of highwall stability against translational failures ahead of mining is suggested. Further recommendations for more detailed and quantitative evaluations of the relevant highwall conditions are given.

28905 **An integrated report on slope failure mechanisms at Goonyella - November 1976.** Gonano, L.P. Mount Waverley, Australia; Commonwealth Scientific and Industrial Research Organization (1980). vp.

The current level of understanding of the mechanisms of highwall and spoil failures in a strip coal mine at Goonyella, Queensland is presented. From records of past failures and the results of numerous field and laboratory investigations, either completed or in progress, tentative conclusions have been drawn on the basic modes of failures and on the factors most relevant to stability. Considerable work is still required to clarify details of mechanisms which act to reduce stability. Recommendations are made for some of this work and for an approach to develop a model to define and predict stability.

28906 **Three dimensional boundary element program for mining applications: MIN3D2.** Wardle, L.J. Mount Waverley, Australia; Commonwealth Scientific and Industrial Research Organization (1980). vp.

This report describes modifications made to a three-dimensional boundary element program (3D2) to facilitate the stress-analysis of underground excavations. The validity of the new version of the program, called MIN3D2, is confirmed by comparison with analytical solutions for displacements and stresses around a spherical cavity in an infinite solid. Complete user input data instructions are given, together with information on execution times and costs, central memory requirements and non-standard sub-routines used.

0130 Transport And Handling

REFER ALSO TO CITATION(S) 28971, 28974, 28977, 28979, 30128

28907 (CONF-820273—, pp 10p, Paper 12) **Rail transport of Alaskan coal.** Jones, F.H. (The Alaska Railroad, Anchorage). 1982. Resource Development Council for Alaska, 444 West 7th Ave., Box 516, Anchorage, AK $30.00.

From 2. Alaska coal marketing conference; Anchorage, AK, USA (18 Feb 1982).

The Alaska Railroad is comprised of 526 miles of mainline and branch line railroad and 128 miles of yards and sidings, totalling 654 miles. It was apparent that to make The Alaska Railroad a viable company, we needed to increase volumes and reduce our expenses. To achieve this, we need to consider exporting coal, for the consumption of coal within the State of Alaska is approximately 700,000 tons annually, and we do transport that coal now. That vision became a reality in December 1980 when 28,000 metric tons of coal were shipped from Alaska to the Republic of Korea for testing purposes. The tests were completed, and the coal has been accepted. The City of Seward has set aside over 80 acres in its industrial park for an export terminal to accommodate future growth in coal and bulk materials. The undeveloped coal resources at Matanuska, Susitna, Yentna, and Beluga are in close proximity to the existing railbelt and rail extensions are technically feasible and highly probable. Presently, there is no rail connection to the Fourth of July Creek Industrial Park but a 5 to 7 mile extension from our existing line is practical when additional volumes dictate greater capacity than the ARR project can handle. The major holders of coal leases adjacent to the Railroad have been doing their planning also and anticipate a need for a facility of this type in the next five to ten years because it will take them that long to develop their mine projects and facilities and a market. The closeness of the mine to tidewater in Alaska provides for economical rail transportation. In nautical miles Alaska is 1075 miles closer to the Republic of Korea than Robert's Bank and 1850 miles closer than Long Beach, and is 1150 miles closer than Sydney, Australia. Transportation, indeed, plays a vital role in placing Alaska coal in the market place.

28908 (CONF-820273—, pp 14p, Paper 13) **Impact of ocean transportation and ports on the marketing of Alaskan coal in the Pacific Rim.** Bowersmith, J. (Soros Associates, New York, NY). 1982. Resource Development Council for Alaska, 444 West 7th Ave., Box 516, Anchorage, AK $30.00.

From 2. Alaska coal marketing conference; Anchorage, AK, USA (18 Feb 1982).

When we look at the entire West Coast of the US, we see bulk facilities that are totally inadequate to accommodate large volume coal movements efficiently. This lack of adequate export facilities puts a serious constraint on the ability to export western coal; but it also presents an opportunity, in that new, modern, high capacity, efficient export terminals will be built which will better service the trade. Alaska, also has the same present constraints to exporting its coal, and the same opportunities to develop ports custom-tailored to the trade. Alaska has a couple of major advantages vis-a-vis ocean transportation over the lower western states. A shorter distance from Alaska's coast to the Pacific Rim market and the availability of deep water ports closely adjacent to the Alaskan coal fields. These factors combine to reduce the cost of ocean transportation from Alaska to the Pacific Rim market. The coal receiving port development programs in Japan, Korea and Taiwan involve major coal centers, electic power ports, and public ports. These planned new ports are identified and located on maps. A modern export terminal includes an inbound coal receiving area when inbound coal arriving by either railroad, truck, conveyor or other mode of transportation is offloaded. The second element is a storage yard including stockpiling and reclaiming equipment. Finally, there is the shiploading area which includes the berth and the shiploader. These three principal elements of the terminal are supported by shops, offices, maintenance facilities, and the environmental control system. As a general rule of thumb capital cost for a high capacity coal terminal varies from $7.00 to $12.00 per ton of annual throughput capacity and the development time would range from 2-1/2 years to 5 years.

28909 (DOE/METC—83-53) **Incident report: performance of the Fuel Preparation Plant to June 1982.** (NCB (IEA Grimethorpe) Ltd., Barnsley, South Yorkshire (UK)). Aug 1982. 21p. NTIS, PC A02/MF A01. Order Number DE83007233.

The report presents the findings of an investigation on the performance of the Fuel Preparation Plant up to June 1982. The Fuel Preparation Plant provides the means for taking raw coal from a stockpile, preparing and blending it with dolomite and pneumatically conveying the blended fuel to the Main Plant. The report describes the process and the main items of equipment, along with the operational problems that were experienced up to the completion of Test Series 1. The plant did not perform consistently during Test Series 1 and the major modification works that have been undertaken, prior to the hot commissioning tests for Test Series 2, are detailed. It was considered that the performance of the Fuel Preparation Plant was significantly affected by the inability to control the moisture in the coal and segregation of the coal in the storage silo, and these concepts are discussed. 2 figures.

28910 (DOE/PETC/TR—83/3) **Reliability of using channel samples to represent run-of-mine coal washability.** Wizzard, J.T. (Department of Energy, Pittsburgh, PA (USA). Pittsburgh Energy Technology Center). Mar 1983. 43p. NTIS, PC A03/MF A01. Order Number DE83009748.

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This paper investigates the reliability of using washability data derived from channel samples to represent the washability characteristics of standard run-of-mine (ROM) coal samples. Separate samples are taken from both ROM coal and channel cut samples from identical coalbeds in a given state. These samples are subjected to identical float-sink tests; and standard coal characteristics, such as weight recovery, % ash composition, % pyritic sulfur composition, % total sulfur composition, and calorific content (Btu/lb), are measured for each float fraction. Statistical tests were performed by comparing the raw coal characteristics of the ROM and channel samples, and the coal characteristics of two sized and float-sink tested coal fractions of the ROM and channel samples. Coal samples from five different coalbeds spanning four different states are examined. The tests indicate that channel samples can be used to represent the coal characteristics of ROM coal for washed coal fractions only. Raw coal values for ash and calorific content, and the reduction values derived from tests on channel samples should not be treated as reliable representations of what would be expected from ROM samples. The raw coal comparisons indicate that the total sulfur and SO_2 emission values for the channel samples do not significantly differ from the corresponding raw coal values for the ROM samples (except for the raw SO_2 values for the Pittsburgh bed in Ohio and the raw total sulfur for the Upper Freeport bed in Pennsylvania). Therefore, channel samples can be used as estimators for determining the amount of SO_2 reduction required to comply with the EPA's New Stationary Point Source Requirements for burning coal.

28911 **Coal preparation for synfuels: where do we stand.** Killmeyer, R.P. (Pittsburgh Mining Technology Center, PA). *Energy Progress;* 2: No. 1, 14-17(Mar 1982).

As the optimum feedstock requirements for synfuels processes become more clearly defined, so will the role of coal preparation in the overall mine-to-fuel scheme. The extent of coal preparation needed will largely depend on the characteristics of the (ROM) coal, the process feedstock specifications, and the overall economics of the system. It has been shown that coal cleaning can have a direct impact on the catalytic reactivity of the feedstock and the synfuel plant throughput on a raw-coal feed basis. These parameters, in turn, affect the product quality and quantity, plant sizing and cost, hydrogen requirements, downstream processing steps, equipment life, and system economics. 4 tables.

28912 **Seventh international technical conference on slurry transportation. Proceedings.** Sakkestad, B.A. (ed.). Washington, DC; Slurry Transport Association (1982). 462p. (CONF-820389—).

From 7. international technical conference on slurry transportation; Lake Tahoe, NV, USA (23 Mar 1982).

The seventh international technical conference on slurry transportation was held at Lake Tahoe, Nevada, March 23-26, 1982. As a significant part of its ongoing effort to foster the development of the slurry transport industry, STA sponsors and conducts this annual series of Technical Conferences. Fifty-three papers have been entered individually into EDB and ERA and one also into EAPA. (LTN)

28913 **ETSI to date.** Wasp, E.J. (ETSI Pipeline Project, San Francisco, CA). pp 5-7 of Proceedings seventh international technical conference on slurry transportation. Sakkestad, B.A. (ed.). Washington, DC; Slurry Transport Association (1982).

From 7. international technical conference on slurry transportation; Lake Tahoe, NV, USA (23 Mar 1982).

The water agreement we signed with the State of South Dakota is a unique and historic accomplishment. It guarantees us a secure water supply for the 50-year estimated lifetime of the ETSI coal slurry pipeline. To bring the water from the Oahe Reservoir near Pierre, South Dakota, to our coal slurry preparation plants near Gillette, Wyoming, we will build a 267-mile and rural water districts in western South Dakota. We expect to pass another major milestone in the very near future when we receive permission to cross 36 miles of federal government land in Wyoming and Colorado administered by the Bureau of Land Management and the US Forest Service. This will be the end result of an intensive environmental impact study conducted under the leadership of the BLM. Our coal evaluation plant has been in operation at White Bluff, Arkansas, since last November. We have confirmed that the design basis for the ETSI line is sound. Our grinding mills are producing pipeline slurry using Powder River Basin coal with minimum dust emission by use of a wet collection system after the cage mills. At the dewatering end, we have confirmed our estimate that the primary dewatering centrifuge would produce about 40 tons of dry coal per hour. The dewatered slurry product handles well on the conveyor belts and can be stored in open piles with conventional equipment. The dewatered slurry coal is much less dusty than standard unit train coal.

28914 **Powder River Pipeline project.** Westhoff, W.J. (Powder River Pipeline, Inc., Jackson, MS). pp 9 of Seventh international technical conference on slurry transportation. Proceedings. Sakkestad, B.A. (ed.). Washington, DC; Slurry Transport Association (1982).

From 7. international technical conference on slurry transportation; Lake Tahoe, NV, USA (23 Mar 1982).

The Powder River Pipeline is a projected pipeline designed to transport coal in slurry form from mines in southeastern Montana and northeastern Wyoming to markets on the Great Lakes, serving markets along the way in the proximity of the pipeline route. The final routing will be a function of the markets attached, the ecological and environmental impact and engineering and economical considerations. Powder River Pipeline Company, Inc. became a reality in February 1981. The feasibility study funded by principals estimated to cost $2 to $3 million, includes: economic and engineering evaluation, appraisal of water availability, preliminary ecological and environmental study to determine fatal flaws, if any, market survey and eminent domain legislation (participation in STA efforts plus additional support by Powder River personnel where personal contacts can be used).

28915 **Alton pipeline Allen-Warner Valley energy system.** Arlidge, J.W. (Nevada Power Co., Las Vegas). pp 11-14 of Seventh international technical conference on slurry transportation. Proceedings. Sakkestad, B.A. (ed.). Washington, DC; Slurry Transport Association (1982).

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The slurry pipeline route requires the crossing of railroad rights-of-way in two locations. However, we were able to find locations where the railroads did not own the land in fee and thus could not block the pipeline route. Water for the slurry will be supplied from a deep groundwater aquifer (1100 to 1500 feet) in the Navajo Sandstone Formation below the Alton Coalfield. The major facilities for the overall pipeline system are: coal slurry preparation plant, main pump station (located at preparation plant sites), valve stations; terminal valves and pressure relief facilities (located at generating stations), electrical substation (located at preparation plant site), communications facilities, maintenance facilities (located at preparation plant site), supervisory control facilities (located at preparation plant site), and airplane landing strips (located at preparation plant, valve station and generating stations). A unique feature of the pipeline system is the valve station, designed into the system on top of the Hurricane Clifs, a 1500-foot scrap. Because of the excessive slope down the cliffs, valves at the top and bottom of the cliffs will be used to eliminate excessive shutoff pressures and provide for drainage of pipeline sections during emergency shutdown. In addition to the valve for the Allen Station pipeline, a slurry storage reservoir will be provided at the Warner Valley Station for drainage of the line. A 6-inch water pipe will run between Warner Valley Station and the valve station on the cliff to provide water for flushing and pipelines after shutdown.

28916 **Coalstream pipeline project.** Dorris, A.D. (Coalstream Pipeline Co., Winter Park, FL). pp 15-16 of Seventh international technical conference on slurry transportation. Proceedings. Sakkestad, B.A. (ed.). Washington, DC; Slurry Transport Association (1982).

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The Coalstream project would gather coal from the Illinois Basin and Appalachia for delivery to 16 electric generating stations in Florida and Georgia. The conceptual design of the system is shown in Figure 1. These 16 plants will have coal requirements exceeding 50 million tons by the end of this decade. We also reported last year that we had just received the results of a study conducted for us by A. T. Kearney, Inc. comparing rail and pipeline rates. That study has received wide distribution and was submitted with other testimony to Congressional committees. The study compares the rail rates permissible under the Staggers Act with pipeline rates, assuming that coal pipeline rates are regulated by the same methodology (ICC valuation) as oil pipelines. It is interesting to note that the savings to the electric utilities to be served by Coalstream, assuming these rates, would be 54 billion dollars during the first twenty yers of operation.

28917 **Pacific bulk transportation system.** Sterry, W.M. (BE and C Engineers, Inc., Tukwilla, WA). pp 17-19 of Seventh international technical conference on slurry transportation. Proceedings. Sakkestad, B.A. (ed.). Washington, DC; Slurry Transport Association (1982).

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Our system concept consists of a slurry pipeline whose head end is near the town of Emery, Utah, and which terminates at the City of Oxnard, California. At Oxnard coal is loaded hydraulically onto very large bulk carriers for transport to Far Eastern markets. Although substantial dewatering takes place prior to ship departure, the ship system is designed for simplicity to ensure rapid, reliable, and low-cost loading. Details of this system concept are shown on Figure 2. Coal preparation takes place at the mine mouth and slurry is delivered to the end of the pipeline by means of relatively short pipeline feeder segments. At the head end of the pipeline coal from various sources is accumulated and introduced into the system at 100 psi. Pumping stations along the route provide sufficient head to overcome frictional losses and the rugged, mountainous terrain. At Oxnard the slurry is dumped into settling ponds where excess water is decanted and then processed in a water treatment plant for local use. Some water is retained in a pond for reclaiming the slurry when a ship arrives for loading. At that time the coal is reslurried and pumped on board the ship where dewatering takes place. Shiploading and dewatering sequences are designed such that the vessel is ready to leave in 48 hours, which is approximately the time that loading alone would require. When the ship arrives at its destination the coal on board is reslurried with water from shore and the slurry is pumped into settling ponds similar to those in the United States. Distribution within the recipient country is by pipeline or by coastal pusher barges. The most significant changes which have occurred during the last year are economic. While the price of US coal has increased modestly, producers in other coun-

tries such as Australia and South Africa have increased their prices substantially.

28918 **San Marco Pipeline.** Gillaspie, M.W. (San Marco Pipeline Co., Houston, TX). pp 21-22 of Seventh international technical conference on slurry transportation. Proceedings. Sakkestad, B.A. (ed.). Washington, DC; Slurry Transport Association (1982).

From 7. international technical conference on slurry transportation; Lake Tahoe, NV, USA (23 Mar 1982).

San Marco Pipeline Company is jointly owned by Houston Natural Gas Corporation and Rio Grande Industries, the parent company of the Denver and Rio Grande Western Railroad. Our concept includes the use of their rail system as a coal gathering network to collect the coal at a slurry preparation facility at Walsenburg, near the Southeast corner of Colorado. The planned capacity of the slurry pipeline system is 10 million tons of coal per year. The length of the proposed pipeline is approximately 900 miles of 24" pipe to the first delivery point and 20" pipe to the terminus of the line, which will be located in the vicinity of Houston, on the intracoastal waterway, giving us access to barge transportation, and route for the line will be tailor-made to most efficiently serve its customers. It is our opinion that with the right of eminent domain bills that were passed in Texas and Oklahoma in 1978, we have the ability to obtain our right-of-way through condemnations, if necessary. Acquisition of a usable water supply is occupying our efforts to further our project. As I reported last year, we purchased land southeast of Alamosa, Colorado, as a center for our water exploration program. A 10-day pump test from a 16" production test well stopped by a long spell of extremely cold weather. This has been completed. These are important points in connection with our application for water rights. Colorado has an anti-export water statute which our legal advisors indicate is unconstitutional under both the Colorado and the Federal constitutions. This issue is included in our water court suit. We are still stalled by the lack of water rights for use in our system. Many of you are aware that Colorado has a water court system that handles all water matters. We filed for water rights four years ago.

28919 **Coal slurry pipelines in Virginia: a preliminary feasibility study status report.** Combs, R.T. (Virginia Electric and Power Co., Richmond). pp 23-26 of Seventh international technical conference on slurry transportation. Proceedings. Sakkestad, B.A. (ed.). Washington, DC; Slurry Transport Association (1982).

From 7. international technical conference on slurry transportation; Lake Tahoe, NV, USA (23 Mar 1982).

In these feasibility studies, it was assumed that the coal slurry transport is from point to point, such as from Big Stone Gap to Portsmouth, Virginia, without intermediate takeoff points, as shown in Figure 1, illustrating possible alternative pipeline routings in Virginia. Actually, four separate pipeline routings were examined. Engineering and economic analyses were done for each of these routes, varying in length from 400 to 465 miles. The studies address the physical features of the slurry pipelines, such as pipeline diameter, number of pumping stations, water requirements, et cetera, as shown in Figure 2. Note that levels of 5, 10, 15, 20, and 25 million tons per year of coal transported were considered. Analyses of 2.5 and 7.5 million tons per year were also made. The slurry transported was assumed to be a 50 to 50% by weight, coal-water slurry. As shown in Figure 3, cost summary tables were prepared for each of the several alternate routes. Total capital costs include beginning of pipe slurry preparation, the pipeline itself, slurry transport pumping facilities, dewatering, and water treatment at the end of the pipe. Note that in this table, capital and operating costs are given in 1981 dollars, and that a 30-year life is considered.

28920 **ETSI Coal Evaluation Plant.** Derammelaere, R.H. (ETSI Pipeline Project, San Francisco, CA) Dina, M.L.; McEwan, P.F. pp 27-32 of Seventh international technical conference on slurry transportation. Proceedings. Sakkestad, B.A. (ed.). Washington, DC; Slurry Transport Association (1982).

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After approximately 600 hours of running, the results of the CEP testwork have been most encouraging: Pipeline specification coal can be produced with the cage mill/rod mill equipment and at energy requirements closely correlating the Black Mesa commercial experience. The commercial screenbowl centrifuge and the vibrating bed dryer have confirmed previous projections of performance. Specification material with surface moistures adjustable between 7 and 11 percent can be produced consistently and with the reliability required for commercial acceptance. The solids carry-over in the vibrating bed dryer is minimal and the nature of the material is such that dust collection equipment operates more efficiently than predicted. Air emissions and wastewater discharge are well within environmental standards. Solids recovery in the dewatering process is complete with the screenbowl effluent being filtered in a continuous belt press and the filtrate from the belt press being recirculated to its feed via a thickener. The overflow from the thickener contains no more than 30 ppM suspended solids.

28921 **Enviromental impact statement: the ETSI project.** Eiserman, F.M.; Troy, H.M. (ETSI Pipeline project, Casper, WY). pp 33-36 of Seventh international technical conference on slurry transportation. Proceedings. Sakkestad, B.A. (ed.). Washington, DC; Slurry Transport Association (1982).

From 7. international technical conference on slurry transportation; Lake Tahoe, NV, USA (23 Mar 1982).

The key issues in the environmental assessment were developed at public scoping sessions conducted by the Bureau of Land Management (BLM) in all states through which the pipeline will cross. Key issues identified were: (1) hydrologic impacts of groundwater withdrawal, (2) socioeconomic impacts of construction and operation, (3) ruptures and spill impacts and (4) energy efficiency of this mode of transportation. The overall cost of the EIS, paid for by ETSI, was approximately six million dollars. One million one hundred thousand dollars was spent by the BLM in addition to more than three million dollars charged to ETSI by the consultant used by the BLM. Finally, where do we go from here in the permitting and licensing process. Early in the project, ETSI developed a plan of action and a schedule for the environmental permitting program. ETSI personnel developed extensive information on permitting and licensing requirements in each of the states through which the pipeline will pass. In addition, state and federal agencies, having a responsibility within the ETSI project area of activities, were contacted. Using this information, ETSI first developed an overall schedule of environmental permit activities. This schedule provided us with an overview of licensing, permitting and compliance requirements.

28922 **Legislative aspects of slurry transportation: luncheon speech.** Breaux, J.B. (The Honorable John B. Breaux, Washington, DC). pp 37-41 of Seventh international technical conference on slurry transportation. Proceedings. Sakkestad, B.A. (ed.). Washington, DC; Slurry Transport Association (1982).

From 7. international technical conference on slurry transportation; Lake Tahoe, NV, USA (23 Mar 1982).

28923 **Technical aspects of shiploading coal slurries.** Faddick, R.R. (Colorado School of Mines, Golden). pp 45-49 of Seventh international technical conference on slurry transportation. Proceedings. Sakkestad, B.A. (ed.). Washington, DC; Slurry Transport Association (1982).

From 7. international technical conference on slurry transportation; Lake Tahoe, NV, USA (23 Mar 1982).

The possibility of loading a ship with coal by hydraulic transport to a single point mooring buoy and then with a flexible hose is considered. Several possible problem areas are discussed: start-up and shut down of the slurry flow, mechanical properties of the 20 inch hose (or perhaps larger), energy requirements, water removal, loading method to minimize ship stresses, etc. (LTN)

28924 **Hydraulic transport of coarse solids in circular and segmented pipes.** Sauermann, H.B. (National Mechanical Engineering Research Inst., Pretoria, South Africa). pp 51-60 of Seventh international technical conference on slurry transportation. Proceedings. Sakkestad, B.A. (ed.). Washington, DC; Slurry Transport Association (1982).

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The tests have shown that the transport of coarse solids through a segmented pipe requires smaller transport velocities and energy for the same amount of solids throughput than through a circular pipe of the same diameter. It was found that at the velocity V, (the velocity at the minimum pressure gradient plus 0.3 m/s), the coarser and the denser the material, i.e., the more the material transported as a sliding bed, the bigger were the reductions in velocity and energy in the segmented pipe. Comparing a segmented pipe with a circular pipe, both having the same throughflow area, the segmented pipe also showed that it was greatly superior to the circular pipe. At the velocity V_1, the transition velocity between sliding bed and heterogeneous flow, the transport of anthracite samples and the smallest sand through the segmented pipe showed no improvement over the circular pipe. The reason is that these materials are fairly uniformly distributed over the cross-section. For the coarser sand samples, although they were transported at the onset of heterogeneous flow, they nevertheless formed a kind of loose sliding bed. For this condition, the segmented pipe was superior to a circular pipe with respect to velocity and energy. The tests have shown without doubt that pipe geometry has an important effect on mixture flow and that the base area of the pipe is a very influential geometric characteristic for the hydraulic transportation of coarse solids.

28925 Hydraulic transport of coal suspensions with coarse particles. Klose, R.B. (Stahlwerke Peine-Salzgitter AG, Salzgitter, West Germany). pp 61-64 of Seventh international technical conference on slurry transportation. Proceedings. Sakkestad, B.A. (ed.). Washington, DC; Slurry Transport Association (1982).

The investigations into the hydrualic transportation of medium coal suspensions have shown very positive results. It is technically and economically possible to transport coking coal and other coals with particle size distributions of less than 8 mm over long distances. The factors relevant to the implementation of a hydrualic transport system from a technical viewpoint are as follows: the type of coal and the particle size distribution along with the pertinent questions as to the type of displacement pumps which must be investigated in detail. The factors which influence the economic viability of such a system include the throughput, distance, as well as treatment, and dewatering of the coal. The tests in our pilot plants have shown that it is possible to transport coking coal with a relatively coarse particle size distribution under favorable conditions over several hundred kilometers and then dewater it mechanically to a residual moisture of less than 10%. The coke produced from this hydraulically transported coal does not differ in any way from normal coke. The transportation of medium coal suspensions seems to be more favorable from an economic point of view than the transportation of normal coal suspensions of less than 1 mm. The treatment and dewatering costs are considerably lower for medium coal suspensions.

28926 Survey of coarse coal slurries. Kakka, R.S.; Gandhi, R.L. (Bechtel Petroleum Inc., San Francisco, CA). pp 65-74 of Seventh international technical conference on slurry transportation. Proceedings. Sakkestad, B.A. (ed.). Washington, DC; Slurry Transport Association (1982).

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This paper addresses the overall design considerations for a coarse coal slurry pipeline system. Selection of flow velocity, slurry concentration and determination of friction losses are discussed. In addition, the attrition of coal particles, pipe erosion, major equipment selection and instrumentation requirements are also reviewed. Potential applications of coarse coal slurry pipeline technology are also identified.

28927 Integration of mine dewatering installations with a hydraulic hoisting system. Sellgren, A. (Univ. of Lulea, Sweden). pp 75-80 of Seventh international technical conference on slurry transportation. Proceedings. Sakkestad, B.A. (ed.). Washington, DC; Slurry Transport Association (1982).

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Conversion into a slurry is often a part of the normal processing of ores and industrial minerals. Therefore, hydraulic hoisting of these products shall be seen as a system in which parts of the mining and processing operations are included. In underground mines there is generally a considerable inflow of ground water which has to be pumped out. Integration of mine dewatering installations with a hydraulic hoisting system provides an efficient way of using the ground water. The effectiveness is strongly dependent on the pump efficiencies and the water availability underground. For example, in a fully integrated system, the cost of energy for pumping fine-grained iron ore is less than the cost of hoisting it mechanically. In addition, the capital cost of hydraulic system is much lower than that of a conventional shaft system.

28928 Coal slurry shiploading world trade applications. Wang, G.S.C. (Bechtel Group, Inc., San Francisco, CA). pp 81-89 of Seventh international technical conference on slurry transportation. Proceedings. Sakkestad, B.A. (ed.). Washington, DC; Slurry Transport Association (1982).

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To alleviate the current congestion in coal ports, coal slurry loading appears to be a technically feasible and economically attractive alternative. In summary, its advantages are: lower loading costs, lower overall delivered fuel costs, shorter construction time, potentially shorter permitting time, less environmental impact, more siting flexibility, fewer shore facilities, no requirement for costly dredging, and ability to accommodate very large ships. Although both the fine coal and coarse coal systems are feasible, they each have certain constraints on near-term development. The fine coal system is based on an overland pipeline from the coal source to the terminal, and none exists at this time. The coarse coal system will require modification of the monobuoy concept to accommodate coarse coal characteristics. Although further development work is required on these systems, the slurry pipeline appears to be an economical and environmentally methods. It is a possible solution to current port congestion caused by an increased demand for steam coal.

28929 Application of the electronicaly controlled synchronous motor to slurry pipeline pumping. Fuchs, E.A.; Gutzwiller, R.A. (General Electric Co., Schenectady, NY). pp 93-103 of Seventh international technical conference on slurry transportation. Proceedings. Sakkestad, B.A. (ed.). Washington, DC; Slurry Transport Association (1982).

From 7. international technical conference on slurry transportation; Lake Tahoe, NV, USA (23 Mar 1982).

In summary, the electronically controlled, adjustable-speed synchronous motor, known as the LCI drive, is an appropriate application for driving a slurry pipeline pump. It compares favorably with the induction motor fluid-drive combination utilized on the successfully operating Black Mesa coal pipeline. The LCI drive design is based upon a concept of maximum reliability in continuous process or base-load applications. Power-carrying, static-controlled-rectifier elements are selected so that fusing is eliminated, thus avoiding loss of reliability associated with nuisance and fatigue-caused fuse operation. Each leg of each power conversion bridge is designed to operate at rated power with one of the thyristors failed, allowing uninterrupted operation until the opportunity for replacement arises. The system design also makes extensive use of the diagnostic capabilities of microprocessor control, allowing self-checking during operation and providing the logic for sophisticated drive system protection. Areas of concern with regard to harmonics generation, power factor and torsional vibration can be (and should be) evaluated in the design stage of the slurry pumping station and necessary corrective measures taken in the designs of the electrical supply, the LCI drive and/or the mechanical drive train. The LCI synchronous moto drive is a unique adaption of a proved, solid-state, power-conversion technology. In the LCI design the inverter follows the frequency of the motor counter-emf, the motor and inverter are always in synchronism, and the motor cannot pull out of step in the event of a sudden increase in load torque. This relationship eliminates the normally expected thermal, electrical and mechanical stresses associated with the high inrush current inherent with starting conventional polyphase motors. Reduced inrush cur-

rent reduces voltage disturbances in the pipeline station and on the utility lines serving the station.

28930 **Application and experience of hydroviscous drives in slurry pipeline pumps service.** Liu, J.K. (Philadelphia Gear Corp., King of Prussia, PA). pp 105-111 of Seventh international technical conference on slurry transportation. Proceedings. Sakkestad, B.A. (ed.). Washington, DC; Slurry Transport Association (1982).

From 7. international technical conference on slurry transportation; Lake Tahoe, NV, USA (23 Mar 1982).

The hydroviscous drive has become an increasingly popular method of varying slurry pump speed in recent years. This type of drive falls in the category of controlled slip drives, which include the well-known fluid drives used on the Black Mesa coal slurry pipeline, but differ from the latter in that the slip may be regulated over a broader range, usually from 0 to 90% slip, whereas the fluid and eddy current drives (both controlled slip drives) can only be regulated from about 3% slip on up. Another advantage of the hydroviscous drive (HVD) is the wide choice of configurations available. The HVD may be installed with integral gearing which either increases or reduces the input speed from the motor (normally a fixed speed induction or synchronous motor), thus matching the required speeds of low RPM reciprocating pumps or the higher RPM's of centrifugal pumps. Besides the obvious space savings, other savings are fewer components, simplified field erection, smaller baseplates or foundations, and unified lube systems. The HVD is a slipping wet clutch with an electronic controller to regulate its speed. Instead of Coulomb friction, the shear stress in the oil firm between the two sets of clutch discs transmits the torque from input to output. Output speed is accurately controlled by comparing this speed continuously with the desired or reference speed. The difference in the two speeds, or error signal, is amplified and drives a servovalve, which raises or lowers the pressure in the piston that closes or opens the oil film between the discs. For a given slip, the shear stress is raised when the oil film closes, and lowered when the oil film opens up. Because of the low control oil volumes and the high overall speed of response of the system, even the torque pulses generated by slowly running piston pumps are smoothed out.

28931 **Plunger flush system.** Null, L.G. (Continental Emsco Co., Houston, TX). pp 113-126 of Seventh international technical conference on slurry transportation. Proceedings. Sakkestad, B.A. (ed.). Washington, DC; Slurry Transport Association (1982).

From 7. international technical conference on slurry transportation; Lake Tahoe, NV, USA (23 Mar 1982).

Positive displacement reciprocating plunger pumps are used on slurry pipelines where abrasive slurries are handled under high pressures. Because of the design of this type of pump, a clean liquid barrier, usually water, can be introduced around the plunger and between the packing and slurry. Ideally, the packing is never exposed to the abrasive slurry and the plunger is flushed clean. This principle is illustrated in Figures 1 and 2. Figure 1 shows a typical arrangement for a plunger pump where the product being pumped comes in contact with the packing. Figure 2 shows a plunger pump with a plunger flush. Pump manufacturers have discovered, however, that this is easier said than done. Several different types of flush systems and unique stuffing box designs have evolved during approximately the last fifteen years. Based on the testing conducted in the present work, orifices were selected which would provide adequate flush water flow to each stuffing box of the slurry pump for all anticipated operating conditions. The stuffing box and lantern ring design were selected which established and maintained a unique flush water flow around the plunger. While this test was a limited evaluation of the plunger flush system, it did provide answers to questions vital to the successful functioning of the system. If the flush system was not capable of operating successfully in this test, if would surely fail in actual operation. Other factors affect the operation of the plunger flush system and must be provided to assure successful operation. These include: good quality packing, good quality plunger coating and finish, good plunger alignment in stuffing box, clean finely filtered flush water and well dampened flush system.

28932 **High pressure coal slurry pumping with hydraulic exchange pumps.** Chowdhury, A.K.; Zoborowski, M.E. (Zimpro, Inc., Rothschild, WI). pp 127-132 of Seventh international technical conference on slurry transportation. Proceedings. Sakkestad, B.A. (ed.). Washington, DC; Slurry Transport Association (1982).

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High pressure pumping of abrasive and viscous slurries has always been difficult. Positive displacement plunger pumps generally used for such services have the disadvantage of high downtime and maintenance costs. Over the last two decades, Zimpro Inc. has developed a positive displacement hydraulic exchange pump which can handle highly abrasive and viscous slurries with high uptime and very low operating costs. These high pressure pumps designed by Zimpro Inc., which use cylindrical diaphragms, ahave been in extensive commercial use for pumping abrasive slurries in the mining and chemical processing industries. Coal slurries, at consistencies approaching the ultimate settled solids concentration, have been pumped successfully in a 5 gpm Zimpro Inc. hydraulic exchange. Zimpro has extensive field experience in operating positive displacement pumps of various designs such as those utilizing piston, plunger, and diaphragms. It is observed, in general, that the costs associated with downtime and maintenance in a typical mechanical reciprocating pump are excessive, especially in pumping abrasive and/or corrosive slurries at high pressure. The uniquely designed positive displacement pumps by Zimpro Inc. have proved to be more reliable and have very low operating costs when compared to other positive displacement pumps. At present, there are over 200 commercial Zimpro Inc. pumps employed in pumping sewage sludge, various industrial wastes, and abrasive and corrosive slurries in the mining, pipeline, and chemical process industries.

28933 **Pump scaling and leakage characteristics of a positive displacement rotary ram slurry pump.** Stewart, B.D. (Univ. of New South Wales, Australia). pp 133-138 of Seventh international technical conference on slurry transportation. Proceedings. Sakkestad, B.A. (ed.). Washington, DC; Slurry Transport Association (1982).

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A theoretical analysis of internal leakage of water to the slurry being pumped in a water-powered, free piston, positive displacement, rotating barrel slurry pump indicates that the water leakage is from the rams pumping the slurry and the rotary slurry valve. The independent design variables which characterize this leakage are the ram to neck bush clearance, the ram diameter and the rotary slurry valve axial clearance. The leakage (dilution) ratio, LR, of slurry being pumped due to leakage of water is expressed as directly proportional to the ratio of h the common clearance of rams and slurry valve to d the ram diameter all raised to the power three and directly proportional to ΔP the pressure difference between lubrication water supply and the slurry inlet pressure. The complete equation which is useful to establish the scaling effects of leakage is $LR = 1.1\ (\Delta P/\mu N)(h/d)^3$ where μ is absolute viscosity of leakage water and N is the rotational speed of the pump. This equation overestimates leakage since the lower leakage during slurry discharge is not accounted for. Limit relationships between ram clearance, valve clearance and ram diameter clearly indicate that slurry dilution of less than 3% is not realistically achievable. This is due to the limitations that the normal machining processes of lapping and fine grinding have on manufacture of the pump components of $h/d = 10^{-4}$ for pumps having slurry ram diameters in the range of 100 mm to 500 mm examined here. This size range of slurry rams is suitable in pumps for slurry pipelines in the same size range.

28934 **Power characteristics of two principal axial impeller types for slurry holding tanks.** Chudacek, M.W. (M.D. Research Company Pty. Ltd., North Ryde, Australia). pp 139-148 of Seventh international technical conference on slurry transportation. Proceedings. Sakkestad, B.A. (ed.). Washington, DC; Slurry Transport Association (1982).

From 7. international technical conference on slurry transportation; Lake Tahoe, NV, USA (23 Mar 1982).

The 3-blade-square-pitch propeller was found to be 30% more efficient than the 6-inclined-blade turbine and 42% more efficient than the 4-inclined-blade turbine for the attainment of complete off-bottom suspension of solids. Also the 3-blade propeller requires less than half the torque required by the 6-inclined-blade turbine to attain complete off-bottom suspension. Therefore, the use of propellers instead of the popularly used inclined-blade turbines would result not only in considerable energy saving but would produce some capital cost saving in drive requirements as well. A distinct optimum clearance (0.5· d) was found for attainment of complete off-bottom suspension with agitation by the 3-blade propeller. The study has shown that the optimum tank height for attainment of complete off-bottom suspension is 0.6 to 0.8 D. However, for operation in the incomplete suspension mode the optimum tank height is lower (0.5 to 0.7 D). These results represent a strong case for the shallower tank design in installations where floor space is not at a premium. The study has demonstrated that the operation of a flat bottom tank in the incomplete suspension mode, i.e., 98% suspended, leads to considerable energy saving when compared to operation in the complete off-bottom suspension mode. Tank geometry based on the flat bottom design has been found in principle unsuitable for efficient attainment of complete off-bottom suspension of solids.

28935 **Effects of viscosity reducing chemical additives on slurry rheology and pipeline transport performance for various mineral slurries.** Sikorski, C.F.; Lehman, R.L.; Shepherd, J.A. (FMC Corp., Princeton, NJ). pp 163-173 of Seventh international technical conference on slurry transportation. Proceedings. Sakkestad, B.A. (ed.). Washington, DC; Slurry Transport Association (1982).

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Among the various flow control methods known, the use of chemical additives has been recognized as an effective measure for slurry viscosity reduction. The advantage arising from the use of chemical additives for viscosity reduction in mineral slurries is commonly manifested in one of the following two ways. In the first case, chemical additives can be used to lower the viscosity of the slurry in question while maintaining a constant solids content. Alternatively, one can maintain a desired viscosity but increase the solids content of the slurry. Depending on the circumstances of the particular application, this advantage can be realized in the form of higher solids throughput, lower water consumption, reduced power requirements, downsizing of pumps, improved ease of operation, and so on. The sections that follow describe general and specific instances where chemical additives have been used to affect the rheological properties of mineral slurries, as studied both in he laboratory and in the field. Although the examples dwell mainly on slurry viscosity control, the cost-effectiveness of additive use has been examined and has been found in each case to favor the application of the particular chemical additive systems presented. The examples cover a range of slurry systems, namely, those of drilling muds, phosphate rock, limestone, and coal.

28936 **Computational approach for coal slurry pipelines.** Roco, M.C. (Univ. of Kentucky, Lexington); Shook, C.A. pp 175-192 of Seventh international technical conference on slurry transportation. Proceedings. Sakkestad, B.A. (ed.). Washington, DC; Slurry Transport Association (1982).

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A computational approach for heterogeneous particle slurry transportation, and in particular for coal slurry pipelines, is proposed. The approach should predict the velocity and concentration distributions, as well as the mixture and solid flow rates versus head losses in pipelines. Design calculations can be performed for any set of given conditions: the properties of the transported material carrier liquid and pipeline. The first test performed with three samples of commercial coal at flow parameters close to those used in the industrial conditions shows the applicability of this approach. A new system of equations to calculate concentration and velocity distributions in multi-species particle flow is derived from the Cauchy momentum equations. The interactions between solid particles, hindered turbulence in the multi-component flow and dispersive stress in flowing suspensions are specific terms that determine the flow in pipelines, especially at high concentrations. The proposed approach can be used to scale-up experimental data from the laboratory to industrial situations. The coefficients used to describe the local flow structure are indirectly established from experimental results: a and b for the diffusion and turbulence phenomena, $\tan\theta$ for the dispersive stress, β for the relative velocity. In the performed tests with sand and coal, these coefficients have similar values. The solid particle concentration and grain size distribution measured in situ in the closed loop experimental installations are different from the delivered concentration and delivered size distribution used as operational parameters in applications. These two parameters have a cumulative effect on head losses. The differences are significant at velocity near the critical value and for heterogeneous materials.

28937 **Computer assisted data analysis of slurry pipeline route selection.** Hartman, R.M. (Envirosphere Co., Norcross, GA). pp 193-195 of Seventh international technical conference on slurry transportation. Proceedings. Sakkestad, B.A. (ed.). Washington, DC; Slurry Transport Association (1982).

From 7. international technical conference on slurry transportation; Lake Tahoe, NV, USA (23 Mar 1982).

Routing a pipeline requires consideration of a wide range of environmental, public interest, and property ownership issues. In order to show that a given route selection is best after consideration of these as well as technical and economic factors, a well organized and systematic route evaluation process is needed. The Federal National Environmental Policy Act requires that a comprehensive evaluation of environmental and public interest factors be evaluated for the preferred as well as for other feasible alternative routes. In addition many states require similar comprehensive evaluations before granting rights-of-way approvals. As a result of these regulatory requirements, it is advisable to follow a thorough and objective evaluation methodology when examining potential corridors for pipelines before selecting the preferred one. Various manual and computer assisted methodologies have been developed for pipeline corridor evaluation studies. The choice between a manual or computer assisted approach is largely determined by the length of the right-of-way, the number of environmental and economic variables within the study area, regulatory requirements, availability of computer hardware and software, and the adequacy of the existing database. Larger study areas and greater degrees of environmental and economic variability dictate more sophisticated modes of data storage, manipulation, and display. Recent developments in data management hardware and software have made investment in a computerized information system more economical and, therefore, more available to users with limited resources. Storage and display of this information on geographic terms makes for greater public understanding and acceptance. This type of computerized information system is generally referred to as a geographic informtion system.

28938 **Laminar transport of Bingham plastic slurries.** Wicker, G.R. (AMAX Extractive Research and Development, Inc., Golden, CO). pp 197-199 of Seventh international technical conference on slurry transportation. Proceedings. Sakkestad, B.A. (ed.). Washington, DC; Slurry Transport Association (1982).

From 7. international technical conference on slurry transportation; Lake Tahoe, NV, USA (23 Mar 1982).

Slurry transport is a convenient means of moving solids due to the fluid properties of the liquid, usually water. In dilute slurries, the fluid properties are not greatly affected by the addition of solid particles. However, in most practical applications, economics favor slurry concentrations which approach the ultimate settled concentration. Under these conditions, the plastic flow properties must be, to some extent, imposed upon the slurry. Interparticle contact and interlocking of particles impart a degree of rigidity to the slurry. It becomes a Bingham plastic and will not flow in a pipe until it is stressed beyond its yield point. Bingham plastic fluids exhibit linear stress-strain relationships. However, unlike Newtonian fluids, they remain in a rigid state until some finite yield stress is exceeded. Laminar and transitional flow of Bingham plastic slurries in pipes is characterized by a rigid plug-flow core. As flow is initiated, only a thin layer at the wall is sheared and the core moves as a solid body. Its diameter is inversely proportional to the pressure drop in the

pipe. As velocity increases, the core diameter shrinks until it is finally destroyed by turbulence. The rheological properties peculiar to Bingham plastic slurries, while troublesome in some applications, can be used to advantage in the transport of concentrates slurries. The problems associated with heterogeneous flow are either reduced or eliminated due to the presence of a yield stress in these slurries. In the transport of Newtonian slurries, the minimum suspension velocity normally falls in the turbulent flow regime. However, laminar and transitional transport is practical in the case of Bingham suspensions. This type of transport is characterized by a plug-flow core and by the reduction or elimination of settling within the core.

28939 **Development of coal/liquid CO_2 slurry transportation: current status.** Santhanam, C.J. pp 203-209 of Seventh international technical conference on slurry transportation. Proceedings. Sakkestad, B.A. (ed.). Washington, DC; Slurry Transport Association (1982).

From 7. international technical conference on slurry transportation; Lake Tahoe, NV, USA (23 Mar 1982).

Of all the non-aqueous media for transportation of coal, liquid CO_2 appears the most attractive for the following reasons: carbon dioxide can be recovered by burning coal with commercially vailable technology. Additionally, a number of sources of CO_2 exist (such as power plant stacks, old natural gas wells from operations, etc.) from which CO_2 can be recovered. Liquid CO_2 has a viscosity of 1/15 to 1/30th of that of coal leading to lower pressure drops. Liquid CO_2 does not cause swelling or agglomeration of coal under typical pipeline conditions. Liquid CO_2 can be loaded to more than 80% by weight with coal as against 45 to 50% for water (for typical western coal). Liquid CO_2 slurry pipelines have two basic configurations - open loop and closed loop.

28940 **Coal transportation: the economic alternatives.** Aude, T.C.; Thompson, T.L. (Pipeline Systems Inc., Orinda, CA). pp 211-216 of Seventh international technical conference on slurry transportation. Proceedings. Sakkestad, B.A. (ed.). Washington, DC; Slurry Transport Association (1982).

From 7. international technical conference on slurry transportation; Lake Tahoe, NV, USA (23 Mar 1982).

The economic analysis presented demonstrates what can be observed in a study of the history of the development of coal transportation. That is, that there is an appropriate mode of transportation of coal for each specific set of distance, volume, and duration circumstances. We can observe the historical development of coal transportation from initial small quantities over short distances carried by wagons or trucks through the development of the nation's railroad infrastructure and unit train movements. If the above analysis is correct, we are on the threshold of entering a period of development of high volume, long distance coal slurry pipelines dedicated to movement from specific mines to specific power plants over the lives of those facilities. This movement toward slurry pipeline transportation is being accelerated by the recent deregulation of railroad tariffs. Railroad tariffs are currently in a phase of rapid upward adjustment and their levels, when they stabilize with general economic movements, are expected to be considerably higher than today. This upward adjustment of unit train rates was not considered in this evaluation and would tend to enlarge the range of volumes and distances appropriate to selection of slurry pipeline transportation. Development of the pipeline infrastructure will not displace the other transportation modes. This analysis shows that conventional slurry pipelines are appropriate to long distance, large volume, long duration movements, whereas other modes are appropriate to other segments of the total coal transportation market.

28941 **Overview of proposed coal slurry technologies and their cost-saving applications.** Lee, H.M. (IEA Coal Research, London, England). pp 217-223 of Seventh international technical conference on slurry transportation. Proceedings. Sakkestad, B.A. (ed.). Washington, DC; Slurry Transport Association (1982).

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The size consist of a coal slurry is of critical importance: smaller particles are easier to pump (at lower speed and less pressure drop), but are harder to dewater. In some proposed applications, other factors are of importance. Low concentration cause coal slurries require more pumping energy but can be used in ship unloading or for short distances (e.g., mine haulage hoisting). Experiments are being carried out with high concentration coarse slurries in a carrier fluid close to coal in density, but they are difficult to pump. Coal-water, coal-fuel oil, and coal-water-fuel oil mixtures are considered for materials handling and combustion. Other fluids than water are considered (oil, methanol, liquid carbon dioxide). All these items should be considered from the point of view of how they fit in the overall coal chain from mine to final use. (LTN)

28942 **Stapleton: proposed coal export terminal on Staten Island, New York, using coal slurry technology.** Orr, L.P. (New York City Dept. of Ports and Terminals, NY). pp 225-232 of Seventh international technical conference on slurry transportation. Proceedings. Sakkestad, B.A. (ed.). Washington, DC; Slurry Transport Association (1982).

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The City of New York is proposing a steam coal export terminal for New York Harbor. We believe the terminal is environmentally acceptable; is consistent with existing land uses; and is economically feasible according to our preliminary evaluation. The port is planned for Stapleton, on the northeastern shore of the New York City borough of Staten Island. Steam coal will be transported to the western shore of Staten Island by unit trains, unloaded and stored in slurry ponds at the Arlington Rail Yard. It will be transported across Staten Island by a coarse coal slurry pipeline. The coal will be dewatered at Stapleton and loaded into colliers at the rate of 4000 tons per hour. Water will be returned to Arlington for reuse. The terminal will be able to handle 20 million tons of steam coal a year at maximum capacity and is scheduled to open in 1986.

28943 **Fosfertil phosphate pipeline: three years of operation.** Albanese, C.R.C.; Farah, M.; Correa, G.C. (Fertilizantes Fosfatados S/A, Araxa, Brazil). pp 233-247 of Seventh international technical conference on slurry transportation. Proceedings. Sakkestad, B.A. (ed.). Washington, DC; Slurry Transport Association (1982).

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The pipeline system was designed by the Pipeline and Production Facilities Division of Bechtel and includes a nine inch diameter pipe capable of transporting 2.0 million dry metric tons of phosphate per year (dmtpy) at 61% solids by weight, with a slurry particle size distribution less than 65 tyler mesh. Difficulty in obtaining adequate slurry characteristics for the slurry, deficient agitation in the storage tanks, main line pump packing failure, sticking of the motorized valves and a pipeline rupture were the main problems we dealt with up to the beginning of 1981. Corrosion associated with incrustation is the present and disturbing problem, especially considering the 20-year designed life for Fosfertil's phosphate slurry pipeline.

28944 **Controlling bulk inventories for slurry preparation.** Howell, R.C. (Brown and Root, Inc., Houston, TX). pp 249-255 of Seventh international technical conference on slurry transportation. Proceedings. Sakkestad, B.A. (ed.). Washington, DC; Slurry Transport Association (1982).

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This paper deals with the blending and storage of inventory before slurry preparation. Potential customers of coal slurry can be assured of a more consistent product if bulk inventories are properly controlled. Designers of control features can benefit by (1) recognizing differences in coal selection, supply, and blending at a slurry preparation plant as opposed to those at, say, a steam generating plant; (2) having a thorough knowledge of available bulk handling equipment and systems; (3) adapting slurry preparation to accommodate variable characteristics of coal; and (4) blending raw coal wherever and whenever the need is indicated. Recent innovations in bulk handling equipment and systems can aid in greater system flexibility and minimizing the costs of transient supply sources.

28945 Coal transport chain: a cost and energy analysis of two technical systems: a slurry system vs a conventional bulk transport system. Prassone, M.; Testa, G.; Ferrini, F.; Foramitti, E.; Giacomazzi, G.; Montellanico, P. pp 257-271 of Seventh international technical conference on slurry transportation. Proceedings. Sakkestad, B.A. (ed.). Washington, DC; Slurry Transport Association (1982).

From 7. international technical conference on slurry transportation; Lake Tahoe, NV, USA (23 Mar 1982).

Transportation cost represents a large portion of the final cost of procuring coal from overseas sources. Also, the energy consumption involved in the transport operations is of ever-growing importance. The aim of this paper is to present a complete evaluation from the mine to the final users. Two systems are studied and compared from both cost and energy points of view. The first system includes coal slurry transmission from the mine to the loading port, seaborne transportation by slurry tankers, discharging by off-shore facilities and distribution to the utilities by a slurry pipeline. The second system includes coal transportation by trains from the mine to the loading port, seaborne transportation by bulk carriers, discharging by conventional facilities and distribution by trains. The calculations are made for different land and marine distances and for different annual throughputs. In the very wide range of sea and land transportation distances considered, a considerable cost and energy savings was obtained in each step by the slurry method and consequently the overall saving is very high. In particular, the cost for the slurry transportation chain ranges between 57% to 61% compared to the bulk system, while the energy requirements of slurry transportation is in the range of 78% to 89% with respect to the bulk system. Besides the considerable advantages obtainable with the slurry system other significant aspects in favor of the slurry system must be borne in mind: higher reliability and efficiency; reduced pollution problems with no spillage during handling; greater possibility of introducing fully automatically controlled systems; limited cost and time necessary to build port terminals, mainly because heavy dredging programs are avoided; and improved utilization of port terminals due to higher overall productivity.

28946 Water quality as a factor in the reuse and disposal of coal slurry water. Peavy, H.S. (Montana State Univ., Bozeman). pp 279-289 of Seventh international technical conference on slurry transportation. Proceedings. Sakkestad, B.A. (ed.). Washington, DC; Slurry Transport Association (1982).

From 7. international technical conference on slurry transportation; Lake Tahoe, NV, USA (23 Mar 1982).

Based on the results of this study, the following conclusions are reached: 1. Chemical interactions do occur between water and coal under simulated conditions of coal-slurry pipelines. Although these interactions do not result in gross pollution of the transort medium, water quality impairment, with respect to some parameters may be significant. 2. Chemical interactions between the water and the coal used in this study resulted in: a decrease in pH of approximately two units (from approximately 8 to approximately 6). Dissolution of metals at a pH of 6 was not significant. b. Increased mineral content of fresh water. Alkalinity, total dissolved solids and sulfates show several-fold increases. c. Turbidity remains in the water after separation of the coal by centrifugation. Although some color may be present as a result of humic acids and manganese, colloidal particles appear to be the main cause of turbidity. d. Dissolved organic carbon levels that may be significant if reuse (either prior to or after discharge) requires chlorination. These organics are potential precursors of chlorinated hydrocarbons. 3. Saline water as a transport medium should be avoided if possible. 4. Treatment of the transport water may be necessary to: reduce mineral content, reduce turbidity or avoid formation of chlorinated hydrocarbons. Both the type and the extent of treatment will be dependent on the nature of reuse/discharge. Wastewater treatment technology is currently available to reduce concentrations of all the contaminants reported in this study to practically any level desired. Removal of the dissolved constituents would be expensive.

28947 Linear routing methodologies to locate slurry pipelines. Dressler, R.L. (Gilbert/Commonwealth, Jackson, MI). pp 291-294 of Seventh international technical conference on slurry transportation. Proceedings. Sakkestad, B.A. (ed.). Washington, DC; Slurry Transport Association (1982).

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Federal approval of eminent domain for these pipelines will reduce many of the problems currently encountered while locating slurry pipelines. However, the slurry pipeline builder must still deal with the problem of selecting the best route: considering environmental, economic and regulatory concerns. To minimize the problems in locating coal slurry pipelines, it is appropriate to draw on the years of experience gained in locating linear facilities such as high voltage electric transmission lines and oil/gas pipelines. While the coal slurry pipeline systems have unique problems at initiation and termination points, the problems related to locating slurry pipelines are not unlike routing other linear facilities. The subject of this paper is the application of proven linear routing techniques to locating coal slurry pipelines and water supply lines for such systems.

28948 Coal slurry dewatering operations wastewater treatability studies. Plummer, A.H. (Alan Plummer and Associates, Inc., Arlington, TX); Jordan, B.; Derammelaere, R.; Sandhu, A. pp 295-305 of Seventh international technical conference on slurry transportation. Proceedings. Sakkestad, B.A. (ed.). Washington, DC; Slurry Transport Association (1982).

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Simulated wastewater characteristics are essentially the same in both Oahe Reservoir and Madison aquifer simulated coal slurry dewatering plant wastewaters. Based on simulation test results, coal slurry dewatering plant wastewater does not contain priority pollutants and contains only very low levels of metals. Biological treatment processes can reduce the total BOD_5 concentration observed in simulated wastewater to the 20 to 40 mg/l range under laboratory conditions. Chemical treatment does not significantly reduce BOD concentrations in the simulated coal slurry dewatering plant wastewater. Powdered activated carbon is only nominally effective in removing COD from the simulated coal slurry dewatering plant wastewater. The large quantities of PAC required to significantly reduce the wastewater organics are cost prohibitive.

28949 Water quality aspects of coal slurry pipelining: a literature survey. Moore, J.W. (Univ. of Arkansas, Fayetteville). pp 307-313 of Seventh international technical conference on slurry transportation. Proceedings. Sakkestad, B.A. (ed.). Washington, DC; Slurry Transport Association (1982).

From 7. international technical conference on slurry transportation; Lake Tahoe, NV, USA (23 Mar 1982).

The coal-water mixture in a coal slurry pipeline represents a complex environment in which numerous phenomena are occurring simultaneously. Leaching of materials from the coal into the aqueous phase results in changes in water quality. Conversely, uptake of some of the ions in the aqueous phase by the coal also occurs. Precipitation of compounds from the liquid phase and neutralization of alkalinity can also occur in the slurry mixture. Several investigators have conducted studies to define the interactions which occur between the coal and water during slurry pipelining. An overall summary of the results of these studies is presented. As would be expected, the two predominant factors influencing the quality of the slurry wastewater resulting from the coal slurry pipelining process are the coal and water sources used. The quality of the slurry wastewater is also dependent on the solids concentration used and on the detention time of the slurry in the pipeline. The data base concerning wastewaters resulting from the slurry pipelining of coal has increased rapidly in the past few years, particularly with respect to Western coals. More limited information is available for slurry wastewaters resulting from Eastern coals. It is the latter area for which more emphasis needs to be placed in the immediate future to more completely characterize slurry wastewater quality, to define treatment needs and to describe treatment processes which are the most appropriate for wastewater quality restoration.

28950 Water quality simulation for the design of the ESTI wastewater treatment facilities. Sandu, A.S. (ESTI Pipeline Project, San Francisco, CA); Gandhi, R.L. pp 315-317 of Seventh international technical conference on slurry transportation. Proceedings. Sakkestad, B.A. (ed.). Washington, DC; Slurry Transport Association (1982).

From 7. international technical conference on slurry transportation; Lake Tahoe, NV, USA (23 Mar 1982).

Federal and state environmental regulations require that before slurry wastewater can be discharged into rivers or streams, it must meet certain quality standards. Only limited data was available on quality of coal slurry wastewater. Due to variability in characteristics of coal and makeup water, it was necessary for ETSI to develop a method of forecasting wastewater quality using the specific coal and water. A bench scale water quality simulation method was devised and tested using the Black Mesa Coal Slurry Pipeline as a prototype. Excellent correlation was obtained between the actual and the simulated water quality characteristics, proving the success of the method employed. Results of water quality simulation tests using different coal and water samples are summarized. Test results of general chemical analysis for Onhe Raw Water, slurry transport water using Black Thunder Coal and Kerr-McGee Coal are compared. Comparison of values indicates that coal slurry transport changes the raw water quality characteristics only slightly. The water in most cases could be discharged without any further treatment.

28951 Calculating transient flows in slurry pipelines. Bechteler, I.W.; Vogel, G. (Hochschule der Bundeswehr, Munchen, Germany). pp 319-324 of Seventh international technical conference on slurry transportation. Proceedings. Sakkestad, B.A. (ed.). Washington, DC; Slurry Transport Association (1982).

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In our last year's contribution to this conference series we mainly presented, derived and discussed two differing equations to calculate waterhammer propagation velocities. The experimental results offered then in the case of sand-water slurries lay between the calculated values; for the coal-water mixtures they were below the theoretical curves. An explanation to this latter result can be seen in the presence of air or gas in the mixture. A new effort has been undertaken to include this third component, the gas, in the basic equations and to account for the added mass phenomenon, which had been left out so far. Furthermore, characteristic equations are given that allow a time- and space-dependent calculation of all variables involved: pressure, flow velocities and concentrations. The introduction of the added mass phenomenon into the basic equations closed the gap between separate and homogeneous flow for pressure wave velocities. Numerically, any transition may be produced between the two. By choosing theoretically based values for the added mass factors, a satisfying consistency was found with the recorded data, at least for the investigated sand-water slurries. Moreover, it has been shown how to do transient calculations of slurry flows without introducing medium densities and that it is possible to obtain distance- and time- dependent relations for all variables involved.

28952 Abrasiveness of fine grain particles in slurry machinery. Elmore, C. (Kamyr, Inc.; Glen Falls, NY); Funk, E.; Rabinowicz, E. pp 327-329 of Seventh international technical conference on slurry transportation. Proceedings. Sakkestad, B.A. (ed.). Washington, DC; Slurry Transport Association (1982).

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Machines that process slurries are subject to abrasive wear by fine grain particles that are present in all slurries whether the slurry is considered coarse or fine. The hardness and abrasiveness of the fine grain particles are major factors in selecting metals for satisfactory service life. It is fine grains that enter small machinery spaces such as centrifugal pump wear rings, packing gland seals, clearances between rotating parts, etc. The fine grains can many times have completely different abrading properties than those of the larger particle mother substance. The abrading qualities of fine grain particles are effected by such factors as particle hardness, sharpness of the particles, and presence of two or more component substances. The mechanism of wear is a complex subject that is thoroughly treated in Reference 1. Designers of slurry machinery, however, need simple qualitative and quantitative guidelines to make proper metals selections for maximum machinery performance at lowest cost. When designing slurry machinery, the engineer must be aware of the hardness and abrasiveness of the ores with which he is dealing. The selection of metal with hardness greater than that of the ore powder wil insure long life. If the ore powder hardness is high but abrasiveness is low, such as with coal, some economy can be achieved with softer metals without significantly sacrificing service life. Particular attention must be given to multicomponent ores. This is reflected in the experiences with coal refuse. In any event, the described method of evaluating the material hardness and abrasiveness provides a good machinery design starting point.

28953 Studies on molybdate as pipeline corrosion inhibitor in coal water slurries. Sastri,V.S. (CANMET, Ottawata); Beauprie, R.; Desgagne, M. pp 331-334 of Seventh international technical conference on slurry transportation. Proceedings. Sakkestad, B.A. (ed.). Washington, DC; Slurry Transport Association (1982).

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Several inhibitors have been tested for reducing the corrosion rates in coal-water systems. Chromate both in high and low concentrations proved to be effective in preventing corrosion in coal-water slurry systems. Although hexavalent chromium in the form of chromate has offered excellent and economical corrosion protection, unfortunately it is no longer acceptable to environmental agencies because chromate is toxic. Thus, increasing efforts are being directed to the search for alternative inhibitors for coal-water slurry systems. One of the most promising inhibitors is molybdate and it is also very low toxicity. Hence, a systematic study of molybdate as an inhibitor in coal-water slurries was undertaken and initial results are reported. Sodium molybdate in a concentration of 100 ppM and at pH 8.5 reduced the wear rate of AISI steel by about 93% to 0.6 mm/a in a coal-water slurry system. A binary system of sodium molybdate/sodium nitrite with concentration ratios varying 10/40 to 40/10 gave an improved performance (0.45 mm/a). A multicomponent system comprised of 20 ppM of sodium molybdate, 5 ppM of MBT, 5 ppM of zinc sulphate and 25 ppM of sodium phosphate gave a wear rate of 0.25 mm/a. However, no attempt was made to optimize this inhibitor system and further tests are required to determine long-term effects. Nevertheless, these preliminary results show that molybdate is a promising inhibitor and could be useful in coal-water slurry systems.

28954 Examination of flexible pipe for slurry use. Mullen, C. (Coflexip and Services, Inc., Houston, TX). pp 335-337 of Seventh international technical conference on slurry transportation. Proceedings. Sakkestad, B.A. (ed.). Washington, DC; Slurry Transport Association (1982).

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This presentation examines flexible pipe and the productive role it can play in a slurry system. Flexible pipe has been used extensively in the offshore oil and gas industries for ten years. The basic techniques have been used to replace conventional rigid pipe solutions in demanding environments. Flexible pipe is made of steel and thermoplastic. Steel components ensure the mechanical performance while the plastic components render the pipe leakproof. The lines are built with negative buoyancy in water, even when full of gas. The typical structure includes five principal and two optional layers, the characteristics and dimensions of which are determined according to the requirements of the service involved.

28955 CRC automatic pipeline welding system. Jones, R.L.; Hall, J. Jr. (CRC Automatic Welding, Houston, TX). pp 339-344 of Seventh international technical conference on slurry transportation. Proceedings. Sakkestad, B.A. (ed.). Washington, DC; Slurry Transport Association (1982).

From 7. international technical conference on slurry transportation; Lake Tahoe, NV, USA (23 Mar 1982).

The need for an automated pipe welding method for land and offshore pipeline construction had been recognized for many

years by 1968 when CRC introduced its automatic pipeline welding system. The new system offered several significant advantages over manual pipeline welding: increased weld metal deposition rate; reduced volume of weld metal; improved consistency of weld strength, toughness and radiographic quality; reduced vulnerability of weld quality to human error; reduced physical strain on the welder/operator; ease of training operators; and reduced manpower and equipment requirements for heavy wall and large diameter pipe. These advantages have led to use of CRC automatic welding equipment in the construction of over eight thousand miles of pipelines around the world. Pipe sizes have range from 16 to 60 inches in diameter with wall-thickensses over one inch. The system has been used in every extreme pipeline environment. Table 1 is a list of pipeline projects that have been constructed since 1978 using CRC automatic welding equipment.

28956 **Lining coal slurry pipeline ponds with soil-cement.** Dinchak, W.G. (Portland Cement Association, Skokie, IL). pp 345-349 of Seventh international technical conference on slurry transportation. Proceedings. Sakkestad, B.A. (ed.). Washington, DC; Slurry Transport Association (1982).

From 7. international technical conference on slurry transportation; Lake Tahoe, NV, USA (23 Mar 1982).

A coal slurry pipeline system will include pumping stations at various intervals along the pipeline. Each of these stations will presumably have some method of storing slurry in case of emergency. The use of ponds for slurry dumping appears to be the most desirable method of storage. In addition, water flushing ponds for storing water used to clean the pipeline may be used. Erosion and seepage control could be necessary for these basins. Over the past 30 years soil-cement has successfully performed in these environments. This is evidenced by the Bonny Reservoir test section and about 240 other projects. Occasionally, it may be necessary to remove sediment or other solids that accumulate on the bottom of these ponds. Front-end loaders or tractors may be used for this purpose. Soil-cement is strong enough to support this equipment. Soil-cement in economical. At $25 to $30 per cubic yard it is lower in cost than most other types of liners. If on-site soils are adequate for making soil-cement the cost is less. Soil-cement can provide a virtually impermeable barrier or liner on the bottom of these ponds. The placement of soil-cement does not require special construction machinery. Ordinary highway equipment which is widely available, can be used for construction. Soil-cement is a viable alternative for lining coal slurry pipeline ponds: it provides durability, strength, economy, virtual impermeability, ease of construction, and environmental acceptability. While other lining materials may have one or more of these benefits, soil-cement has demonstrated that all these benefits can be realized. It has been effectively and economically used as erosion and seepage control for reservoirs and ponds. Considerable sums have been saved by using soil-cement rather than more expensive materials.

28957 **Pipe behavior in bottom ash slurry systems.** Kovago, J. (M.H. Detrick Co., Linwood, NJ). pp 351-367 of Seventh international technical conference on slurry transportation. Proceedings. Sakkestad, B.A. (ed.). Washington, DC; Slurry Transport Association (1982).

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Bottom ash gained in cyclone furnaces is more abrasive than the normal wet bottom ash. The first is hard, brittle, and sharp edged, while the second is fairly soft and its more rounded exterior surface usually contains less sharp edges. The major difficulty in regard to the ash quality is that it is unknown when the slurry system is designed. It will be known only after the unit will be in operation. Finally, the major factor of service life is the quality of the pipe. Unfortunately, no practical guidance has emerged in the field of bottom ash slurry systems which would render some objective basis for a judgment on the potential service lives of various piping materials in a specific service. The length of the warranty provided by the manufacturer is probably the only guide. As far as the actual service life of a pipe is concerned, the following general rule may render some practical guidance: as long as the pipe internal surface remains smooth and even in a slurry system, it would render a maintenance free service. Whenever the internal pipe surface begins to roughen, it should be inspected fairly frequently and whenever the internal surface becomes extremely rough, it must be recognized that actual failure will occur in a much shorter time than it was expected. Depending on the pump arrangement, this last condition could also be discovered by the pump operation, since in this phase of the service the friction head will show considerable increase.

28958 **Effect of particle size distribution on the economics of short distance coal slurry pipelines.** Elsibai, N.G.; Snoek, P.E.; Pitts, J.D. (Bechtel Petroleum, Inc., San Francisco, CA). pp 371-375 of Seventh international technical conference on slurry transportation. Proceedings. Sakkestad, B.A. (ed.). Washington, DC; Slurry Transport Association (1982).

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Preliminary analyses have been conducted on the economics of coal transportation for two size consists as a function of throughput and distance. Under the bases taken for this study, coarse coal pipeline systems handling a 50 mm x 0 product were found to offer lower transportation costs for distances less than about 40 km at a throughput level of 2.27 mtpy and less than 90 km for a 4.55 mtpy system. Attrition, however, is a major consideration for a coarse coal pipeline and can alter these cross-over points. Furthermore, the study assigned relatively high dewatering costs to the fine coal system. Should extration steam be available or the need for complete secondary dewatering be eliminated, the fine coal systems would be more economically attractive and competitive at considerably shorter distances. Finally, it must be remembered that economics will often not be the deciding factor in particle size selection. Marketing constraints and end use requirements may dictate the final choice.

28959 **Alberta coal supply pipeline study - 1981.** Jacques, R.B. (Fluor Ocean Services, Inc., Houston, TX); Aude, T.C.; Ricks, B.L.; Rabb, D. pp 377-388 of Seventh international technical conference on slurry transportation. Proceedings. Sakkestad, B.A. (ed.). Washington, DC; Slurry Transport Association (1982).

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The results of this study have verified the feasibility of transporting Alberta thermal coal to the British Columbia coast. The following points can be stated: a water source that meets system quality and quantity requirements has been identified. Analysis of the coal to be shipped indicates that state-of-the-art design and equipment can be used to produce and transport the coal slurry from mine to port site. A pipeline route has been selected that will permit adherence to the design requirements of a slurry pipeline system. The pipeline will be buried at a depth sufficient to assure continuous operation without concern as to ambient conditions. A port site has been selected with adequate land for a terminal facility. Water depth sufficient to berth carriers up to 250,000 DWT is available close to the shoreline. State-of-the-art technology can be utilized to dewater coal for either slurry or dry bulk loading.

28960 **Computer application of a preliminary feasibility model to a Turkish iron-ore and a Virginia coal slurry pipeline.** Yucel, O.; Dabak, T. (Virginia Polytechnica Inst., Blacksburg). pp 389-398 of Seventh international technical conference on slurry transportation. Proceedings. Sakkestad, B.A. (ed.). Washington, DC; Slurry Transport Association (1982).

From 7. international technical conference on slurry transportation; Lake Tahoe, NV, USA (23 Mar 1982).

Application of a computer model for preliminary feasibility of slurry pipelines has been made to two specific cases in two different countries and concerning two different materials subject to pipeline transportation. Both applications have produced reasonable results in favor of the slurry pipelines.

28961 Prediction of size degradation of coarse coal during slurry pipeline transportation. Mikhail, M.W. (Western Research Lab., Alberta, CA); Mikula, R.J.; Husband, W.H.W. pp 399-404 of Seventh international technical conference on slurry transportation. Proceedings. Sakkestad, B.A. (ed.). Washington, DC; Slurry Transport Association (1982).

From 7. international technical conference on slurry transportation; Lake Tahoe, NV, USA (23 Mar 1982).

During the transportation of friable coals via slurry pipelines, some degradation inevitably occurs. The fine material produced increases the cost of dewatering and may adversely affect the quality of metallurgical coals. Evidence is presented that permits prediction of the relative size degradation that occurs during slurry pipeline transportation of various coals. Data from a standardized procedure for measuring the rate of methane desorption from a coal sample (ΔP index), is correlated with data from pilot scale slurry pipeline tests. The ΔP index is related to coal microfissuration and hence to friability. Four coal samples of 50 mm top size, ranging from subbituminous to medium-volatile bituminous, were used for attrition testing in a 158 mm diameter pipeline after pumping for one to four hours. Several samples were collected for analysis to determine size degradation and for the laboratory measurement of the ΔP index. The results indicate a linear relationship between the ΔP index and the amount of minus 0.6 mm coal generated during the pipeline attrition tests. Similarly, the coals with higher ΔP indices showed greater amounts of minus 0.1 mm material. It is suggested that the rate of gas desorption, as indicated by the ΔP index, is dependent upon the degree of fissuration of the coal sample and the greater the fissuration, the greater the size degradation during slurry pipeline transport. The relationship between the amount of fines produced during attrition in the pipeline and the ΔP index can then be used for qualitative predictions of the size degradation that will occur during slurry pipeline transportation of other coals.

28962 Removal of fines from recirculation water in a coal slurry system. Bigley, D.N.; Coudriet, L.A.; Decker, C.J. pp 405-410 of Seventh international technical conference on slurry transportation. Proceedings. Sakkestad, B.A. (ed.). Washington, DC; Slurry Transport Association (1982).

From 7. international technical conference on slurry transportation; Lake Tahoe, NV, USA (23 Mar 1982).

Part of the coal mined at Consolidation Coal Company's Loveridge Mine near Fairview, West Virginia, is slurried and transported from the face to preparation facilities through a new hydraulic system designed and implemented by Conoco research engineers, and Consol operating personnel. The coal slurry transportation loop to transport deep mined coal to a surface preparation plant several miles away experienced an unexpected amount of fine material in the transportation loop. The system was designed so that this fine material would generally be removed at the coal preparation facility. These design expectations were not substantiated by actual operating experience, and fine coal accumulated in the recirculation water loop. This resulted in unnecessary water, filling of process vessels, and imminent viscosity changes, etc. The Barrett Haetjens HYDRA was chosen to remove these settled solids based on availability and likelihood of success. It was an easily retrofitted sludge removal system which could be installed in the water return tank.

28963 Novel slurry transport medium. Bradley, G.M. (Petrolite Corp., St. Louis, MO). pp 411-418 of Seventh international technical conference on slurry transportation. Proceedings. Sakkestad, B.A. (ed.). Washington, DC; Slurry Transport Association (1982).

From 7. international technical conference on slurry transportation; Lake Tahoe, NV, USA (23 Mar 1982).

Slurry rheology is a critical matter for the successful operation of a pipeline. Using current technology the flow rates must be maintained within a certain range, the lower end determined by the settling rate of the slurry and the upper end by considerations of abrasion. For a given flow rate, the presure drop should be as low as possible to minimize cost, yet the solids loading should be as high as possible to maximize throughput. Improvements in settling can be obtained by purposefully making the particle-size distribution biomodal. Rheological behavior approaches that of a Bingham plastic. Coarser particles can be pumped, since the yield stress prevents settling. Flow will generally be laminar, reducing the effects of erosion. However, a certain proportion of coal must be ground extremely fine to produce the effect. The improvements in rheology must be balanced against increased grinding and dewatering expenses. Moreover, the properties of the slurry must be controlled rather closely. Another alternative is the use of an emulsion, instead of plain water, as the carrier fluid. The emulsion itself provides the yield stress to suspend particles permanently, avoiding the disadvantages of using fine particles for this purpose. Particles as large as desired can be suspended depending on the properties of the emulsion, which can be varied at will. The only limitations on particle size will be set by mechanical considerations, i.e., pumps, valves, etc. Figures 1 and 2 compare the two processes, emulsion transport and aqueous slurry transport.

28964 Operating experience of the Black Mesa Pipeline. Montfort, J.G. (Black Mesa Pipeline, Inc., Flagstaff, AZ). pp 421-429 of Seventh international technical conference on slurry transportation. Proceedings. Sakkestad, B.A. (ed.). Washington, DC; Slurry Transport Association (1982).

From 7. international technical conference on slurry transportation; Lake Tahoe, NV, USA (23 Mar 1982).

Black Mesa Pipeline was soundly designed and has performed well. The toughest problems about coal slurry involve coal dewatering, storage and utilization. For restartability, a sufficiently fine consist is fundamental; the Black Mesa consist is marginal on the safe side. Effective maintenance involving good people, facilities, equipment and spare parts is essential for reliable operations.

28965 Maintenance of coal slurry dewatering equipment and the application of a Predix diagnostic system. Halloran, J.J.; Smith, D.J. pp 431-442 of Seventh international technical conference on slurry transportation. Proceedings. Sakkestad, B.A. (ed.). Washington, DC; Slurry Transport Association (1982).

From 7. international technical conference on slurry transportation; Lake Tahoe, NV, USA (23 Mar 1982).

Implementation of the service center concept at the Mohave Generating Station has played a key role in maximizing the availability of the coal processing equipment at this slurry-fired plant. The daily access to O.E.M. expertise has enhanced the ability to continually improve the equipment service life and availability. This has been accomplished through expert supervision, product improvement, and development of sophisticated maintenance planning and scheduling techniques.

0140 Combustion

REFER ALSO TO CITATION(S) 28820, 28868, 28977, 28979, 29497, 29519, 29520, 30313

28966 (DOE/FC—1007) Combustion testing of San Miguel lignite. Jones, M.L.; Goblirsch, G.M. (Department of Energy, Grand Forks, ND (USA). Grand Forks Energy Technology Center). 1982. 18p. (CONF-821182—1). NTIS, PC A02/MF A01. Order Number DE83009844.

From Gulf coast lignite conference; Houston, TX, USA (3 Nov 1982).

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Results from pilot plant testing of the San Miguel lignite are: (1) The ash fouling furnace is an empirical tool which provides good information on relative fouling potential of various fuels. In the case of San Miguel lignite tests suggest a severe fouling problem is conventional boiler designs are employed. (2) No effect in either deposition rate or deposit strength was seen when MgO and $CaCO_3$ were used at additives. For these tests a single addition rate was utilizing two different injection points in the system. (3) No bed agglomeration was noted under the varied run conditions used in testing of this lignite fuel. (4) The atmospheric fluidized-bed combustor (AFBC) NO/sub x/ level emitted in the flue gas were always less than the NSPS limit of 0.6 lbs $NO_x/10^6$ Btu. (5) Utilization of inherent alkali was less than that observed for North Dakota lignites. It was possible to meet NSPS standards of 90 percent sulfur capture using limestone addition. (6) Pulverized-coal combus-

tion of San Miguel lignite resulted in a larger portion of <1 μm size particulates than has been noted in similar tests with the Arapahoe subbituminous coal and the Ledbetter Texas lignite. (7) The composition of particulates from P-C combustion of San Miguel lignite has a more varied composition than has been seen in testing with other types of coal. Use of lower grade fuels such as the lignite from the San Miguel mine is inevitable if we are to meet the expanding needs for energy in the United States today. To make use of these different fuels extensive testing on laboratory and pilot scales will be beneficial in avoiding major problems due to the different characteristics these materials possess. The present successful operation of a full scale boiler using the San Miguel lignite is a good example of the value pilot scale studies can have on the road to successful operation.

28967 **(DOE/MC/16000—1294-Vol.1) Modeling of fluidized-bed combustion of coal. Volume I. AFBC system model description. Final report.** Louis, J.F.; Tung, S.E.; Park, D. (Massachusetts Inst. of Tech., Cambridge (USA). Energy Lab.). May 1982. Contract AC21-81MC16000. 123p. NTIS, PC A06/MF A01. Order Number DE83001905.

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The system model has been developed for the simulation of AFBC performances at various conditions. With given input values, the model characterizes fluid dynamical behavior of the bed and calculates combustion efficiency, sulfur retention efficiency, heat transfer coefficients for the tubes, emission of NO and CO, etc. The system model is a steady state model, so it does not simulate dynamic change of the FBC performance with time. Even at steady state conditions comprehensive modeling of FBC System is a complicated task. Thus it is inevitable to use a digital computer for model calculations. The system model is coded in FORTRAN for Multics which is the operating system of a Honeywell machine at M.I.T. Information Processing Center. A specific subsystem called TPSA was developed within Multics to facilitate the use of the system model. To use the model outside the TPSA one should modify input/output interphase because the model is tuned to TPSA environment which is specially designed for the system model in Multics environment. Conceptually the model consists of five component submodels: fluid dynamics, combustion and CO emission, heat transfer, desulfurization, and NO. The relationship among submodels is schematically depicted in Figure 1. Calculation results of fluid dynamics (i.e., bed height, characteristics of bubbles, etc.) are used as input to other submodels, and combustion calculation results as input to NO model, and so on. In this modular structure we have tried to make it easier for the experts of each field to concentrate on their specific field for the model development. These component models are in turn transformed to about 50 fortran subroutines which are for one or more of the submodels. In this report descriptions of component models are given and the list of input/output variables and subroutines is in appendices. Also is given a sample calculation to demonstrate the use of the model.

28968 **(DOE/PC/30306—T10) Basic combustion and pollutant-formation processes for pulverized fuels. Quarterly technical progress report No. 10, 1 January 1983-31 March 1983.** Germane, G.J.; Smoot, L.D. (Brigham Young Univ., Provo, UT (USA). Combustion Lab.). 15 Apr 1983. Contract FG22-80PC30306. 57p. NTIS, PC A04/MF A01. Order Number DE83010627.

This contract study of basic combustion and pollutant formation processes for pulverized solid fossil fuels was initiated on October 1, 1980. The fossil fuels under consideration include coal-water mixtures (CWM) and coal chars derived from pyrolysis, liquefaction or gasification processes. Seventeen steady-state CWM combustion tests were conducted with the seven-section cylindrical reactor as part of the detailed combustor mapping test plan. Three values of stoichiometric ratio and four theoretical swirl numbers up to 8.26 were varied for each test to identify conditions of optimum burnout. Particles and gas samples were collected through the sampling probe near the reactor exit plane. Coal burnout was calculated from both ASTM ashing tests and elemental analysis of the sampled particles and ranged from 84 to 99+%. The test slurry was supplied by Atlantic Research Corporation and contained 70% coal. The Combustion Laboratory slurry nozzle was used for all tests, and combustion parameters such as secondary air temperatures, atomizing air and burner configuration were held fixed for all tests.

28969 **Chemical vapor deposition of sialon.** Casey, A.W.; Landingham, R.L. (to Dept. of Energy). US Patent 4,336,304. 22 Jun 1982. Filed date 21 May 1979. vp.

PAT-APPL-040810.

A laminated composite and a method for forming the composite by chemical vapor deposition. The composite includes a layer of sialon and a material to which the layer is bonded. The method includes the steps of exposing a surface of the material to an ammonia containing atmosphere; heating the surface to at least about 1200° C; and impinging a gas containing in a flowing atmosphere of air N^2, $SiCl_4$, and $AlCl_3$ on the surface.

28970 **(NP-tr—3901618) Pulverized-coal burner with low NO/sub x/ emission.** Michelfelder, S.; Leikert, K. Translated from *Staub - Reinhaltung der Luft ;* **39**: No. 11, 403-404(1979). 8p. NTIS (US Sales Only), PC A02/MF A01. Order Number DE83901618.

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In some highly industrial areas in Germany, as elsewhere, short-term local concentration peaks of 0.3 mg NO_2/m^3 air have been observed. These high local concentrations are mainly due to NOx-emission from industrial processes. For these reasons, permissible NOx-emission from industrial processes is increasingly being restricted in nearly all industrial countries. NOx-emissions can be reduced by means of expensive flue-gas purification equipment or by controlling the process of NOx-formation. This article describes the development of a pulverised-coal burner with low NOx-formation and practical tests in a 700 MW power station unit. First results of demonstration tests with newly designed, pulverised coal, incremental mixing burners demonstrate the efficiency of the design with respect to the reduction of NOx-emission from coal-fired stations. Although due to the limited experience gained in demonstration tests in a power station with only one type of coal, a generalization of the result is not yet possible and since long term results are not available yet (results concerning side effects which are not expected but possible and have not been evaluated yet, e.g. increased material corrosion), the incremental mixing principle appears to be an effective new concept for environmentally benign power generation from coal. If further measurements come up to expectation, this concept could, without great expenditure, halve the NOx-emission of coal fired stations with dry ash removal or, looking at it from a different point of view, the capacity of a modern coal fired station could be doubled without additional NOx-emission.

0150 Marketing And Economics

REFER ALSO TO CITATION(S) 28876, 28883, 28884, 28886, 28983, 29492, 30594

28971 **(CONF-820273—) Alaska coal marketing conference: proceedings.** (Resource Development Council for Alaska, Inc., Anchorage (USA); Alaska Dept. of Commerce and Economic Development, Juneau (USA)). 1982. 193p. Resource Development Council for Alaska, 444 West 7th Ave., Box 516, Anchorage, AK $30.00.

From 2. Alaska coal marketing conference; Anchorage, AK, USA (18 Feb 1982).

The Alaska Coal Marketing Conference was held February 18-19, 1982, at Anchorage, Alaska. While most of the papers dealt with the possibility of financing subbituminous coal mines in Alaska and transporting and marketing the coal to Pacific Rim countries (Japan, Korea and Taiwan), there were a few papers on other subjects: The World Energy and Raw Material Crisis by Governor Dixie Lee Ray, The State of California Energy Policy and on METHACOAL in particular. Twenty-three papers have been entered individually into EDB and ERA and four also into EAPA. (LTN)

28972 (CONF-820273—, pp 4, Paper 2) **Pacific Rim steam coal demand.** McCoy, M.R. (Getty Oil Co., Los Angeles, CA). 1982. Resource Development Council for Alaska, 444 West 7th Ave., Box 516, Anchorage, AK $30.00.

From 2. Alaska coal marketing conference; Anchorage, AK, USA (18 Feb 1982).

The demonstrated reserves of the Western United States are 99 billion tons with an additional 140 billion tons in Alaska - more than adequate reserve base to serve not only the growing Pacific Basin market but the domestic market in the United States as well. The most important outcome of the WESTPO study will not be found in any of the published reports. The real benefit of the study was the dialogue that developed among the participants, the coal consumers, producers, transporters, and port developers. The WESTPO study indicated the potential market share for Western United States coal could be 8 to 11 million tons in 1985 and 19 to 26 million tons in 1990. Several factors which will obviously affect the United States market share are: modern ports; reasonable rail rates; price competitiveness; coal quality; security of supply; capacity of competitors; and diversification policy of buyers. The market for Western coal export will be determined by how we as an industry, as a country, work together to develop this potential on a strong competitive base. We have the coal resources, the technology, the competitive spirit, the free enterprise approach, the support of both the administration in Washington and the western governors, and the reliability. The United States stands ready to capture a major share of this growing coal market, and by doing so, to strengthen the bonds that exist between the Pacific Rim countries and the Untied States.

28973 (CONF-820273—, pp 3p, Paper 6) **Alaska-labor policies.** Lundell, G.H. (Alaska Dept. of Labor, Juneau). 1982. Resource Development Council for Alaska, 444 West 7th Ave., Box 516, Anchorage, AK $30.00.

From 2. Alaska coal marketing conference; Anchorage, AK, USA (18 Feb 1982).

Alaska's single largest construction project was the building of the Trans-Alaska oil pipeline system. One notable result of pipeline construction was a permanent increase in the number of experienced construction workers residing in the state. Many of those who participated in the project stayed in Alaska, anticipating other construction jobs on which they could use their skills. The Federal Mine Safety and Health Administration (MSHA) has jurisdiction over occupational safety and health matters in coal mines. The Alaska Department of Labor, however, has responsibility over any construction contractor who is engaged by a mine operator for construction, repair, or alteration of structures or utilities or roads located on a coal mine. The Department will provide at the employer's request, consultative services including on-site visits to advise employers as to safety and health concerns. The Department also offers a number of employment services - counseling, testing, screening of applicants, job referrals and job placements. Department staff is available to provide assistance in Worker's Compensation and Wage and Hour matters. With the development of a new industry in an area, some occupational skills are bound to be in short supply. A knowledge of industry plans and needs enable the development of training programs to ensure an adequate supply of workers. The State of Alaska stands ready to assist in developing employment and training opportunities to address this need. We encourage a cooperative effort between government and private industry to assure that opportunities for Alaskans are maximized.

28974 (CONF-820273—, pp 10p, Paper 15) **Alaska-coal industry forecasting.** Bagge, C. (National Coal Association, Washington, DC). 1982. Resource Development Council for Alaska, 444 West 7th Ave., Box 516, Anchorage, AK $30.00.

From 2. Alaska coal marketing conference; Anchorage, AK, USA (18 Feb 1982).

The American coal industry is the most advanced in the world with a quarter-million men and women working for more than 3000 coal companies. The United States is blessed with the world's finest coal transportation system. The American coal industry enjoyed its best production ever last year. At the same time, we were shipping overseas more than 110 million tons of coal, including the first shipments from Alaska. More than forty percent of these exports were steam coal. If you've paid attention to export markets, you are also aware that we had some coal-handling problems at our ports. It's impossible to build port capacity to handle a flood of steam coal exports faster than OPEC ministers can raise oil prices. American private enterprise is quickly meeting the challenge to improve our ports with rapid construction of new facilities. By the end of next year at least 150 million more tons of capacity are expected to be in place, ending all demurrage charges. Another 150 million more tons of capacity will be in service by 1985. The point about future readiness can't be missed when we talk about dredging our harbors. The new class of super colliers can cut overseas coal transportation rates as much as 40 percent, and keep our pricing advantage in international markets. Swift Congressional action to speed up harbor dredging will send a clear signal to our trading partners that the United States intends to meet its responsibilities. As so many other public projects in recent years, harbor dredging is mired in red tape. So much so, that it now take an average of 14 years from the time these projects are started until they are finished. There is no excuse for this kind of delay, particularly at a time when our energy and economic needs are some compelling. The red tape must be cut. The rules and regulations can be streamlined. These projects have to move faster than an Alaskan glacier.

28975 (CONF-820273—, pp 3p, Paper 16) **Legislative priorities for coal development in Alaska.** Fahrenkamp, B. (Alaska State Senate, Juneau). 1982. Resource Development Council for Alaska, 444 West 7th Ave., Box 516, Anchorage, AK $30.00.

From 2. Alaska coal marketing conference; Anchorage, AK, USA (18 Feb 1982).

The author discusses legislation with respect to surface mining and reclamation. Also, the problem of whether coal mines should be taxed or whether the industry should be given financial incentives to assure its development. The state does not expect another Prudhoe Bay from coal. It wants to cooperate and review places with respect to ports, transportation needs and rights-of-way. (LTN)

28976 (CONF-820273—, pp 6p, Paper 20) **International financing of Alaska coal ventures.** de Rothschild, E. (NM Rothschild and Sons Ltd., London, England). 1982. Resource Development Council for Alaska, 444 West 7th Ave., Box 516, Anchorage, AK $30.00.

From 2. Alaska coal marketing conference; Anchorage, AK, USA (18 Feb 1982).

Various possible methods of financing a large new coal mine in Alaska are described: (1) by a large company; (2) project financing (where the lenders rely principally on the cash flow from the project for interest and repayments on the loan (but bankers will not usually accept equity risks); and (3) sometimes the coal buyer will subscribe to equity in the mine or make advance payments. The use of Export Credits to assist in the financing of coal projects is worth considering and can be attractive - this concept is described in some detail. Again some reasonable assurance of success is required. (LTN)

28977 (CONF-820273—, pp 7p, Paper 25) **Methacoal fuels, or coal-alcohol slurry fuels, an entree for methanol to world markets.** Keller, L.J. (Methacoal Corp., Dallas, TX). 1982. Resource Development Council for Alaska, 444 West 7th Ave., Box 516, Anchorage, AK $30.00.

From 2. Alaska coal marketing conference; Anchorage, AK, USA (18 Feb 1982).

The commercialization and widespread implementation of the METHACOAL technologies, as described herein, can provide a near-term, dependable market for several millions of tons per year of fuel-grade methanol, or crude methanol as it will be referred to herein. In order to bring facilities into production in a reasonably short period of time, it is imperative that the crude methanol be produced from natural gas. The optimum situations are those where remote natural gas, which has little market potential or value, can be found in close proximity to large coal resources, and where those coal resources are near a seacoast location where large tankers or supertankers can be used to transport the METHACOAL fuels to world markets. There are sufficient natural gas and coal resources in optimum or near-optimum location situations so that all

of the fuel oil burned in boilers throughout the entire world could be replaced by METHACOAL fluid fuels in just a few years time. To convert all of the oil-fired power plants in the United States, about 140,000 megawatts, by building new coal-fired plants would cost about $180 billion; converting them to METHACOAL fuels is estimated to cost about $14 billion, or less than ten percent of the cost for new conventional coal-fired plants. Economic feasibility studies indicate that reductions in fuel cost by converting oil-fired boilers to METHACOAL fluid fuels may range from around ten percent to as much as thirty or forty percent in some cases. The anticipated payback periods for recovering the cost of boiler or power plant conversions from fuel savings range from about three months to one year, depending on a variety of factors. Several other factors are considered.

28978 **(DOE/EIA—0121(82/4Q)) Quarterly coal report, October-December 1982.** (USDOE Energy Information Administration, Washington, DC. Office of Coal, Nuclear, Electric and Alternate Fuels). 1983. 81p. NTIS, PC A05/MF A01. Order Number DE83010913.

This report presents comprehensive information about coal production, exports, imports, receipts, consumption, and stocks in the United States. This issue shows detailed quarterly data for October-December 1982, aggregated quarterly historical and projected data for 1980 through 1983, and aggregated annual historical and projected data for 1960 through 1990. Coal production declined to 1963 million short tons in the fourth quarter of 1982, down 1.9% from the previous quarter. However, total coal production for the year reached an estimated 833.4 million short tons to top the previous record of 829.7 million short tons in 1980. Domestic coal consumption totaled 707.0 million short tons in 1982 which is 25.6 million short tons less than 1981. Coal exports in 1982 totaled 106.3 million short tons, less than in 1981. Coal stocks held by producers and distributors and by consumers were considerably higher at the end of 1982 than at the end of 1981. In 1983 domestic coal consumption is projected to be 736.7 million short tons which is 4.2% higher than 1982. However, exports are expected to decline by 8.5 million short tons. Consumer stocks will not increase by as much in 1983 as in 1982. (ATT)

28979 **(ECE/COAL—72) The role of coal in supplying the ECE region with energy and raw materials in the light of new techniques of coal conversion and utilization.** (United Nations, New York (USA)). 18 Oct 1982. 86p. United Nations, New York, NY.

The report is divided into three main parts, with a summary of the conclusions added. The use of new coal extraction methods in the future is discussed with sections on coal production, coal processing, transportation of coal and the production of smokeless fuel for municipal and household use. The effects of the application of new technologies on the development of the coal industry and its role in the economy are considered. The development of coal production to meet fuel requirements, the utilization of hitherto inaccessible coal reserves and the expansion of the international coal trade are discussed. Finally the necessary measures to ensure international cooperation are considered.

28980 **The present situation and future of Canadian coal.** Ichihara, S. *Tetsu To Hagane;* **68**: No. 6, 553-562(1982). (In Japanese).

Japan will be importing metallurgical coal from Canada for many years, with new and existing contracts together coming to 20 million t/y. In order to investigate the feasibility of this long-term supply, analyses are made of the future supply situation of coal, the Canadian energy situation, the present state of coal and its supply and demand structure, and of transport problems connected with Canadian coal. The outlook for the future is surveyed, and accounts are given of expected trends in coal supply and demand, of forecasts for export supply power, and of government policies relating to coal exporting. (12 refs.)

0160 Health And Safety

REFER ALSO TO CITATION(S) 28875, 28887, 29082, 30577

28981 **(DOE/PC/30098—T4) Development of environment assessment screening criteria for coal conversion solid wastes. Final draft report.** (Bioassay Systems Corp., Woburn, MA (USA)). 12 Mar 1982. 312p. NTIS, PC A14/MF A01. Order Number DE82022259.

The overall objective of this project was to devise a scientifically-sound and cost-effective battery of screening bioassays which can be used in the assessment of the environmental and health effects of various coal conversion solid wastes. The project consisted of the following 5 discrete tasks: review of existing health and environmental effects information; identification and selection of relevant assessment criteria (bioassay methods); application of selected bioassay battery to coal conversion waste samples; evaluation of the test battery and recommendations for future analysis of coal conversion wastes; and preparation of draft and final reports. This report has been organized to describe the results of the work done under each of these project tasks. The report describes the methods utilized in searching the literature and the criteria used to evaluate information obtained from the different literature references. Results of this study strongly suggest the need for using a battery of bioassays for proper assessment of coal conversion solid wastes. The inclusion of different biological systems (rodents, microorganisms, plants, algae) and the use of different end-points allows a more accurate toxicological profile, since the different assays are indicative of different deleterious biological activities, i.e., acutely toxic, mutagenic, phytotoxic. The DMSO and the carbonic acid extraction procedure yielded a combined leachate that was adequate for health effects evaluation but that was still large incompatible with the environmental effects bioassays.

28982 (LA—9640-SR, pp 54-57) **Light activation of natural and synthetic petroleums.** Strniste, G.F.; Bingham, J.M.; Chen, D.J.; Okinaka, R.T. Feb 1983. NTIS, PC A06/MF A01.

In Los Alamos integrated oil shale health and environmental program. Status report II.

Photo-oxidation of complex organic mixtures by sunlight after their discharge by industry or by accidental spillage presents an environmental hazard of unassessed magnitude. Of equal importance is the assessment of potential health risks associated with occupational and public exposure to industrial effluents and/or waste streams plus light. In this article, we summarize data concerning NUV-induced cytotoxicity and mutagenicity in cultured Chinese hamster (CHO) cells after treatment with dilutions of various natural or synthetic petroleums. Data indicate that significant mutagenicity occurs in cells exposed to high dilutions of certain synthetic crude oils and nominal exposure to NUV.

0170 Legislation And Regulations

REFER ALSO TO CITATION(S) 28883, 28884, 28922, 29766, 29767

28983 (CONF-820273—, pp 5p, Paper 5) **Alaska-state government policies.** Morris, W.H. (Dept. of Commerce, Washington, DC). 1982. Resource Development Council for Alaska, 444 West 7th Ave., Box 516, Anchorage, AK $30.00.

From 2. Alaska coal marketing conference; Anchorage, AK, USA (18 Feb 1982).

Some of the key elements of the Reagan administraton's policy are: the Federal Government's role is not to subsidize coal exports, but to expedite them; we will reduce obstacles to coal exporting created by over-regulation and unnecessary red tape; the Army Corps of Engineers will improve its ability to expedite permit-issuing and construction of projects, both private and public; all governmental bodies will work to ensure that federal policies are mindful of, and do not impede, export as well as domestic needs; the administration will see that coal leasing targets and procedures take due consideration of potential export demand; following traditional American policy, this administration welcomes for-

eign participation in the financing of coal projects, consistent with state and federal law; and finally, the administration has pledged not to interrupt coal trade under contractual commitment, unless forced to do so by a severe national emergency. The coal interagency working group has moved quickly to implement these principles, and to undertake promotional activities, to demonstrate to the world our commitment to competing in the world coal market. Accomplishing this of course involves legal, political, economic and practical considerations. The regulatory reform aspects are being taken up in close cooperation with the President's task force on Regulatory Relief. We have already had discussions with a number of potential customers from both European and Pacific nations.

28984 (CONF-820273—, pp 4p, Paper 10) **Taxing Alaskan oil.** Williams, T.K. (Alaska Dept. of Revenue, Juneau). 1982. Resource Development Council for Alaska, 444 West 7th Ave., Box 516, Anchorage, AK $30.00.

From 2. Alaska coal marketing conference; Anchorage, AK, USA (18 Feb 1982).

Coal and other hardrock mineral resources promise to be primary cornerstones of Alaska's economy by the end of this century and for most of the next. The fulfillment of this promise will require major undertakings, massive investment, considerable skill, patient care and maybe some old-fashioned good luck - on both the part of industry and of government. For these developments to come about, industry and government must recognize that they are, in effect, in a kind of partnership with one another. Each brings certain things to the partnership which the other cannot provide; both can supplement the other. It is imperative that each fully understand its own role to be played in this arrangement from the beginning, rather than improvise as they go along. Only in this way can a stable relationship form which will allow the planning and investments for such major developments to proceed. The example of the oil industry in Alaska since the discovery at Prudhoe Bay provides an illustration of how not to form such a partnership. The story should be well known to all, of the many changes that have been enacted in the State's oil and gas tax laws since 1969. This is not the place to recount all those changes or what they were. Rather, what is worth noting here is the fact that, first, they were numerous, and second, they mostly represented increases in the overall tax burden borne by that industry. These actions were hardly the basis for a sound, ongoing relationship between the oil companies and the State, and in fact, a lot of what happened can be fairly described as confrontation. What went wrong, that the State should feel obliged repeatedly to alter what it was getting from its partnership with oil. An explanation is given based on major differences between the situation in Alaska and in the lower 48 states.

28985 (CONF-820273—, pp 11p, Paper 23) **Analysis of environmental regulations pertaining to coal mining and export facilities in Alaska.** Osias, J.; Rybock, J.; Burden, P.; White J. 1982. Resource Development Council for Alaska, 444 West 7th Ave., Box 516, Anchorage, AK $30.00.

From 2. Alaska coal marketing conference; Anchorage, AK, USA (18 Feb 1982).

Coal developers would be well advised to become familiar with both existing and proposed regulations that may influence project permitting. Since these regulations specify permitting procedures and the type of environmental information that must be submitted with the permit applications, wasted time and duplication of effort can be prevented by designing permitting strategies and environmental data collection programs that satisfy these requirements. The purpose of this paper is to provide an overview of the current status of environmental permitting requirements for coal mining and export projects in Alaska. Where appropriate experience obtained in the contiguous US is incorporated in this overview, but for the most part it concentrates on environmental permitting requirements unique to Alaska and on those permits that will be most costly and time consuming to obtain. Finally, strategies for facilitating the permitting process are recommended. Specific permitting strategies will vary from project to project depending on a variey of factors. Thus, one of the first steps in project planning should be to identify these factors and define a permitting strategy that minimizes potential project delays and makes maximum use of available resources.

02 PETROLEUM

0201 Reserves

28986 (DOE/EIA—0381) **Petroleum resources of the North Sea.** Dietzman, W.D.; Rafidi, N.R.; Ross, T.A. (USDOE Energy Information Administration, Washington, DC. Office of Oil and Gas). Feb 1983. 100p. NTIS, PC A05/MF A01. Order Number DE83010200.

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This report presents an analysis of the potential future oil supply capability from the North Sea. Presented herein are estimates of (1) original oil in place; (2) ultimate recovery; (3) remaining recoverable oil; and (4) projected supply patterns over time. This study indicates that the estimated remaining recoverable oil in the area from known deposits is about 25.6 billion barrels as of January 1, 1982, and the total undiscovered recoverable oil has an estimated statistical mean value of 19.9 billion barrels with 12.7 billion barrels of that amount occurring below the sixty-second parallel. Substantial additional producing capacity might be developed, about 2.0 million barrels of oil per day and perhaps higher, especially from the United Kingdom and Norwegian sectors of the northern North Sea basin. Output from the area in 1981 was about 4.3 percent of the world total. As of January 1, 1982, there were at least 242 developed and undeveloped oil fields in the North Sea that originally contained about 96 billion barrels of oil in place and had an estimated proved reserve of 19.8 billion barrels and an undeveloped reserve of 5.7 billion barrels of oil remaining to be recovered. Cumulative production to January 1, 1982, was 3.6 billion barrels, giving a total estimated ultimate oil recovery of 29.1 billion barrels and a recovery efficiency of 30.5 percent of the original oil in place.From an estimated total resource base of 41.9 billion barrels of recoverable oil below the sixty-second parallel, an estimated theoretical peak production rate of 4.3 million barrels of oil per day could be obtained and might occur as early as 1990. From an estimated total resource base of 49.0 billion barrels of recoverable oil both above and below the sixty-second parallel, an estimated theoretical peak production rate of 5.1 million barrels of oil per day might be obtained with the peak occurring in 1991.

0202 Geology And Exploration

REFER ALSO TO CITATION(S) 30594

28987 (IFP—30-340) **Integro-variational formulation for interior and exterior problems of linear hydrodynamics.** Berhault, C. (Institut Francais du Petrole (IFP), 92 - Rueil-Malmaison; Ecole Nationale Superieure de Mecanique, 44 - Nantes (France)). Nov 1981. 98p. (In French). NTIS (US Sales Only), PC A05/MF A01. Order Number DE83750441.

Portions are illegible in microfiche products; Thesis.

This study was performed in relation to the design of fixed and floating offshore structures used for offshore oil exploration. In part 1, a simple example is used to show that, using certain hypotheses, a hydrodynamics problem can be be reduced to the resolution of a Laplace equation in a bounded region, with Neumann or Robin-Fourier conditions at the boundary. The different methods normally used for this resolution are then presented: fluid finite elements and integral equations. Continuing with this simple case of the internal problem, the steps are then indicated leading to the integro-variational formulations. Part 2 is devoted to the problem of diffraction/radiation (wave behaviour), using the same plan as above, and illustrated by some numerical results. Part 3 compares the different methods qualitatively and quantitatively (results, computer time, storage space). It also offers some possibilities of the application of the method to other problems related to hydrodynamics

28988 **Magnitude and detailed structure of residual oil saturation.** Chatzis, I.; Morrow, N.R.; Lim, H.T. (New Mexico Inst. of Mining and Tech., Socorro). *Society of Petroleum Engineers of A.I.M.E. (American Institute of Mining, Metallurgical and Petroleum Engineers), Paper;* 111-130(1982). (CONF-820419—). Contract AS19-80BC10310.

Experimental results are presented which demonstrate the effect on residual oil, under water-wet conditions, of particle size, particle size distribution, macroscopic and microscopic heterogeneities, microscopic dimensions such as ratio of pore body to pore throat size, and pore-to-pore coordination number. Experiments were performed in random packs of equal spheres, heterogeneous packs of spheres with microscopic and macroscopic heterogeneities, two-dimensional capillary networks having various pore geometries, and Berea sandstone. Detailed information on residual oil structure is presented, including blob size distributions of residual oil. Major conclusions are: (1) residual saturationds are independent of absolute pore size, per se, in systems of similar pore geometry; (2) well-mixed two-component aggregates of spheres gave virtually the same residual saturations as random packings of equal spheres; (3) clusters of large pores accessible through small pores will retain oil; (4) high aspect ratios tend to cause entrapment of oil as a large number of relatively small blobs, each held in single pores; and (5) the role of pore-to-pore coordination unber is generally secondary, hence correlations which have been proposed between residual oil and coordination number are unreliable.

0203 Drilling And Production

REFER ALSO TO CITATION(S) 28935, 29950, 29951, 30039

28989 **(BNL—51595) Identification of water requirements for selected enhanced oil recovery methods.** Royce, B.; Kaplan, E.; Garrell, M.; Geffen, T.M. (Brookhaven National Lab., Upton, NY (USA)). Sep 1982. Contract AC02-76CH00016. 52p. NTIS, PC A04/MF A01. Order Number DE83010357.

Water requirements for enhanced oil recovery (EOR) are thoroughly evaluated by using publicly available information, data from actual field applications, and information provided by knowledgeable EOR technologists in fourteen major oil companies. The different uses of water in selected EOR methods, as well as current research trends, are discussed. Water quantity and quality requirements are estimated for individual EOR processes (steam drive; in situ combustion; and carbon dioxide, micellar-polymer, polymer, and caustic flooding) in those states and specific geographical locations where these processes will likely play major roles in future petroleum production by the year 2000. The estimated quantity requirements represent the total water needed from all sources (e.g., aquifers, lakes, produced water). A reduction in these quantities can be achieved by reinjecting all of the produced water potentially available for recycle (e.g., some is lost in oil and water separation and water treatment processes) in the oil recovery method. For injection water quality requirements, it is noted that not all of the water used for EOR needs to be fresh. The use of treated produced water can significantly reduce the quantities of fresh water that would be sought from other sources. Although no major EOR project to date has been abandoned because of water supply problems, competing regional uses for water, drought situations, and scarcity of high quality (e.g., low total dissolved solids) surface water and ground water could be impediments to certain projects in the near future. 4 figures, 14 tables.

28990 **(DOE/BETC—82/4) Contracts for field projects and supporting research on enhanced oil recovery and improved drilling technology. Progress review No. 32, quarter ending September 30, 1982.** Linville, B. (ed.). (USDOE Bartlesville Energy Technology Center, OK). Jan 1983. 117p. NTIS, PC A06/MF A01. Order Number DE83010273.

Progress reports are presented of contracts for field projects and supporting research on chemical flooding, carbon dioxide injection, thermal/heavy oil, resource assessment technology, extraction technology, environmental and safety, microbial enhanced oil recovery, oil recovery by gravity mining, improved drilling technology, and general supporting research.

28991 **(DOE/METC/TPR—83-4) Effects of petroleum-reservoir conditions on oil recovery by carbon dioxide injection.** Comberiati, J.R.; Zammerilli, A.M. (Department of Energy, Morgantown, WV (USA). Morgantown Energy Technology Center). Nov 1982. 50p. NTIS, PC A03/MF A01. Order Number DE83008455.

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Several petroleum reservoir conditions were evaluated to determine their effects on oil recovery by CO_2 injection. The conditions studied were reservoir temperature, reservoir pressure, and CO_2 slug injection size. With constant pressure, the reservoir temperature was varied from 75° to 130°F, and optimum oil recovery was obtained at a temperature near the critical temperature of CO_2 (87.8°F). When the temperature was held constant and the reservoir pressure varied from 650 to 1800 psi, it was found that miscibility pressure may be above but close to 1800 psi. The CO_2 slug injection size has been varied from 3% to over 40% PV to determine if oil recovery would increase with increase of CO_2 slug size. Graphic representation of the results show that a maximum slope is reached between 12 and 15% PV. Above 15% the slope becomes smaller. It is concluded that optimum oil recovery lies between 12 and 15% PV, and the additional oil recovered, above a 15% PV CO_2 slug, would not warrant the increased cost of the CO_2. 13 figures, 13 tables.

28992 (EPRI-EA/EM—2893, pp 5.1-5.13) **Cogeneration in enhanced oil recovery operations.** Gillespie, G.R. (TOSCO Corp., Los Angeles, CA). Feb 1983. NTIS, PC A21/MF A01.

From EPRI cogeneration seminar; Berkeley, CA, USA (28 Jul 1982).

Techniques for utilizing steam produced in cogeneration systems for enhanced oil recovery (EOR) operations are described. The 2 systems discussed are cyclic stimulation and direct steam drive or steam flood. No effort is made to produce high quality steam for this purpose since the cost for purifying the water would not be economically feasible. However, it is important to match the steam load and the electrical load. (DMC)

28993 **(SAND—82-1963) Polycrystalline-diamond drill bits for Venezuelan oil-field application.** Heckes, A.A.; Meano, W.; Baker, L.E. (Sandia National Labs., Albuquerque, NM (USA); INTEVEP, Filial de Petroleos de Venezuela, SA, Caracas; Baker (L.E.), Midland, TX (USA)). Apr 1983. Contract AC04-76DP00789. 57p. NTIS, PC A04/MF A01. Order Number DE83010976.

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A cooperative USA/Venezuelan R and D drilling program has been performed which was directed toward the development of a hard-rock-drilling capability for the oil industry using diffusion-bonded polycrystalline-diamond compact (PDC) bits. The drilling program was implemented according to Annex V-A Drilling, of the Joint Agreement between the Department of Energy (DOE) of the United States and the Ministry of Energy and Mines (MEM) of the Republic of Venezuela. This report was originally prepared in two sections, one on bit design and fabrication and the other on the field test, to be a portion of a larger Venezuela-MEM/USA-DOE Fossil-Energy Report on Supporting Technology for Enhanced Oil Recovery. As such, it fulfills one of the requirements of the joint agreement. Three diffusion-bonded PDC drill bits of PCI/Sandia design were successfully used by MARAVEN/INTEVEP to drill the deep (13,152 to 14,579 ft) cretaceous carbonate formations located under Lake Maracaibo, Venezuela. The bits gave penetration rates of 4.7, 13.2, and 13.5 feet per hour. This compares with penetration rates for conventional natural-diamond bits, drilling the same formation in nearby offset wells, of 2.0 to 6.77 feet per hour. If PDC bits are used to drill future wells, an average cost savings of about $90,000 per well is projected. 17 figures, 9 tables.

28994 **(SAND—83-0117) Sandia Heavy Oil Subprogram. FY 1982 annual report.** Wayland, J.R.; Lee, D.O. (eds.). (Sandia National Labs., Albuquerque, NM (USA)). Apr 1983. 77p. NTIS, PC A05/MF A01. Order Number DE83010898.

The Sandia National Laboratories Heavy Oil Subprogram is concerned with the evaluation of the controlled source audiofrequency magnetotelluric (CSAMT) technique for surface mapping of thermal fronts associated with enhanced oil recovery (EOR). The activities from October 1, 1981, to September 30, 1982, included scaled laboratory CSAMT experiments, a development of grid electode sensors which were placed in a combustion tube to monitor the changes in electrical properties during a burn, analysis of these data, the development of frontal stability analysis, thermal gravimetric analysis (TGA) studies, an analysis of a field experiment where the CSAMT technique was used to monitor a fire flood and the development of a steam quality tool. A summary of these activities is given in this report. 40 figures.

28995 **(UCID—19732) Residual and heavy-oil recovery using directionally drilled wells.** Thompson, D.S. (Lawrence Livermore National Lab., CA (USA)). Mar 1983. Contract W-7405-ENG-48. 13p. NTIS, PC A02/MF A01. Order Number DE83010980.

The application of high-angle directional drilling to the various processes involved in enhanced oil recovery (EOR) could significantly improve reservoir production coefficients over and above those currently being achieved. Heavy oils, light residual oil, and primary production from low-permeability formations are all candidate resources for this application. This report briefly treats recent attractive developments in directional drilling technology and discusses how this effort could assist in the broader application of deviated process wells. Discussion includes the proposed orientation of near-horizontal production wells within a drainage scheme. Also included is a proposed method for using various combinations of directionally drilled injection and production wells designed for stimulation or flooding EOR processes. 6 figures.

28996 **Phases and interfacial tensions of aqueous/hydrocarbon systems containing low-equivalent-weight organic salts.** Ho, P.C. (Oak Ridge National Lab., TN). *Journal of Physical Chemistry;* **86**: No. 23, 4634-4642(11 Nov 1982). Contract W-7405-ENG-26.

Miscibility diagrams for systems containing a hydrocarbon, water, a low-equivalent-weight organic salt, an alcohol, and, in some cases, an inorganic salt do not undergo a sharp discontinuous transition as the equivalent weight of the organic electrolyte is increased into the surfactant range, where micellar and other aggregates are known to form. Three-phase regions are found with compounds of low degrees of alkyl substitution ("protosurfactant") as they are with surfactants. Scans of phase volumes as the concentration of one component is changed are qualitatively similar for the two, although the concentration range over which the middle phase (sometimes characterized as a microemulsion with surfactants) persists is wider for the protosurfactant systems investigated here than is usual with surfactants. Low interfacial tensions (IFT) are observed; values are ultralow (of the order of 10^{-3} dyn/cm) in some cases between adjacent phases (lower vs. middle or middle vs. upper). These low tensions, the sharpness of transitions between two and three phases with compositional changes, and observations of opalescence imply that the postulation of proximity to critical end points suggested to correlate such properties of surfactant systems is also applicable here.

28997 **Microemulsion phase behavior. Four-phase progressions in five-component mixtures.** Bennett, K.E.; Davis, H.T.; Scriven, L.E. (University of Minnesota, Minneapolis). *Journal of Physical Chemistry;* **86**: No. 20, 3917-3919(30 Sep 1982).

The phase behavior of microemulsions of brine, hydrocarbon, alcohol, and a pure alkylarylsulfonate-sodium 4-(1'-heptylnonyl)benzenesulfonate (SHBS or Texas No. 1)-was investigated under conditions where four equilibrium liquid phases are present. Systematic progressions from three phases to four phases (two microemulsion phases) to three phases with changing temperature and salinity are reported for the first time. The observed sequences of phase splits are described in terms of inferred phase diagrams. The collapse of a four-phase tie tetrahedron into a critical tie triangle is discussed.

28998 **Third joint SPE/DOE symposium on enhanced oil recovery.** Dallas, TX; Society of Petroleum Engineers of AIME (1982). 936p. (CONF-820419—). Society of Petroleum Engineers of AIME, 6200 N. Central Expwy., Dallas, TX 75206.

From Enhanced oil recovery symposium; Tulsa, OK, USA (4 Apr 1982).

Separate abstracts were prepared for each of the 53 papers.

28999 **Rules for achieving high solubilization of brine and oil by amphiphilic molecules.** Bourrel, M.; Chambu, C. *Society of Petroleum Engineers of A.I.M.E. (American Institute of Mining, Metallurgical and Petroleum Engineers), Paper;* 17-34(1982). (CONF-820419—).

The oil recovery effectiveness of a chemical flood has been shown to be related to the phase behavior of the brine-oil-surfactant system. In particular, it is advantageous to formulate the system so that optimum three phase behavior is obtained. However, it has also been demonstrated that all the optimized systems are not equivalent in terms of solubilization, interfacial tensions and oil recovery efficiency. The question addressed in this paper concerns the conditions which promote high solubilization into microemulsions, a property which has been shown correlated to the values of the interfacial tensions and therefore to the ability of such systems to displace the oil in porous media. When one formulation parameter is changed, another parameter must be varied at the same time for compensation to reoptimize the system. The mechanisms of solubilization is investigated experimentally by considering the usual formulation parameters: salinity, oil type, alcohol, type and concentration and surfactant structure and type (anionics and nonionics). The results are interpreted in terms of interaction energies between surfactant, oil and water. In particular, the role of the alcohol and its impact on the solubilization by amphiphilic systems are discussed in detail and interpreted. Moreover, the concepts developed in this paper provide a tool to explain the effect of the surfactant structure and therefore to design amphiphilic molecules exhibiting a high solubilizing power for given conditions of brine, temperature, etc.

29000 **Effect of live crude on phase behavior and oil recovery efficiency of surfactant flooding systems.** Nelson, R.C. *Society of Petroleum Engineers of A.I.M.E. (American Institute of Mining, Metallurgical and Petroleum Engineers), Paper;* 35-50(1982). (CONF-820419—).

Results of experiments reported in this paper reduce, but do not eliminate, concern that surfactant flooding systems optimized against stock tank oil under atmospheric pressure may not be optimum against live crude, containing a substantial quantity of dissolved gas, under reservoir pressure. Pressure alone was found to have no effect on phase behavior of a surfactant/bine/stock tank oil system at constant temperature. Nor did pressurizing the stock tank oil with methane change the phase behavior. Oil recovery efficiency in core floods was not significantly different whether the stock tank oil was pressurized with methane or diluted with osoctane to the viscosity of the live crude. In contract, phase behavior and oil recovery efficiency did change upon methane pressurization when a lower molar volume synthetic oil was substituted for the stock tank oil. Some thermodynamic insight regarding the different behavior of the two oils is offered.

29001 **Three-parameter representation of surfactant-oil-brine interaction.** Puerto, M.C.; Reed, R.L. *Society of Petroleum Engineers of A.I.M.E. (American Institute of Mining, Metallurgical and Petroleum Engineers), Paper;* 51-75(1982). (CONF-820419—).

When optimal salinity, C/sub phi/, and solubilization parameter, V/sub o//V/sub s/, are augmented by oil molar volume, v/sub o/, the resultingthree-parameter representation provides a more nearly unique description of microemulsion phase behavior than has previously been available. It then becomes possible to introducr the idea of equivalent oils as a replacement for th equivalent alkane carbon number, which is shown to lack some of the properties needed to implement efficient preliminary screening of microemulsions for enhanced oil recovery. Broadly speaking, two oils are considered equivalent if they have equal viscosity and provide the same phase behavior as a function of surfactant concentration and

salinity in the neighborhood of the optimal salinity locus. It is anticipated that, when these conditions are satisfied, flooding results will also be the same. It should then be possible to replace microemulsion floods of live crude at high pressure with floods of appropriately diluted dead crude at low pressure. This paper places equivalent alkane carbon number in perspective by means of the three-parameter representation; explores parallel effects of temperature and alcohol cosolvents; compares different kinds of lipophile branching; and reveals essential non-linearities in optimal salinity as a function of oil composition (and hence molar volume) for mixtures of various oils. Much of this is subsequently used to develop methods for preparation of equivalent oils and the more complex but evidently essential equivalent systems needed to model live crudes.

29002 **Seismic imaging in enhanced recovery.** Nur, A.M. (Stanford Univ., CA). *Society of Petroleum Engineers of A.I.M.E. (American Institute of Mining, Metallurgical and Petroleum Engineers), Paper;* 99-109(1982). (CONF-820419—).

Laboratory measurements of seismic velocities and attenuation in fluid saturated rock samples strongly suggest that detectable changes in these properties are anticipated upon steam flooding of heave oil reservoirs, or during other EOR operations. Such changes could be monitored with seismic array of receivers and transmitters situated around the region of enhanced recovery. The array will yield seismic wave travel times and amplitudes and their temporal and spatial changes. Inverting these measured values, it is possible to determine the distribution of velocities and Q within the reservoir. These distributions can uniquely be interpreted in terms of the distribution of a steam phase in the reservoir, using laboratory determined seismic response of reservoir rock samples.

29003 **Alteration of rock properties by adsorption of petroleum heavy ends: implications for enhanced oil recovery.** Clementz, D.M. *Society of Petroleum Engineers of A.I.M.E. (American Institute of Mining, Metallurgical and Petroleum Engineers), Paper;* 131-138(1982). (CONF-820419—).

Clay mineral properties are irreversibly altered by adsorption of petroleum heavy ends. As a result of this alteration, rock sensitivity to injected fluids is reduced; rock wettability is changed from water wet to neutral; adsorption of surfactants is reduced; rock property measurements are changed; and cores can be irreversibly altered. All of these changes can affect enhanced recovery processes and related laboratory studies. The extent of this interaction has been found to depend upon the type of clay minerals present in the rock, the composition of the petroleum heavy ends, and the interaction environment. After the adsorption occurs, a clay-organic complex is formed which is hydrophobic and very stable. Expansion of swelling clays is reduced and clay surface area and cation exchange capacity are reduced. Practical implications of these observations are demonstrated in Berea sandstone cores and in friable California sand cores when the clays were stabilized against dispersion and subsequent migration. Berea sandstone permeability is rendered insensitive to fresh water and the friable sand, in which clays are the primary cementing material, is stabilized against failure under increased flow rates. In other studies, surfactant adsorption on montmorillonite was found to be three to ten times lower when the clay was pretreated with petroleum heavy ends. Surfactant retention in clean Nevada sand is also reduced when a surface layer of heavy ends is present on the sand grains.

29004 **Three-phase quantitative monitoring method for CO_2 floods.** Svor, T.R.; Globe, M.P. *Society of Petroleum Engineers of A.I.M.E. (American Institute of Mining, Metallurgical and Petroleum Engineers), Paper;* 139-147(1982). (CONF-820419—).

Pulsed neutron logs have been used effectively for monitoring reservoir changes and, in many cases, predicting current water saturation. Monitoring becomes much more complicated when tthree phases (water, oil, and CO_2) are considered simulataneously for analysis. Complex lithology and the resultant differences in the neutron capture cross section (sigma) of the rock matrix further complicate the determination of water and CO_2 saturation. The proposed technique uses open hole digital log analysis and a base run pulsed neutron log (PNC) to compute triangles whose vertices represent sigma and ratio (net near to far detector count rate) of 100% oil, water, and CO_2 saturations for the given porosities. The triangles are computed and stored on a foot-by-foot basis. Subsequent PNC rund are analyzed by locating the latest sigma/ratio data point within its previously determined triangle and solving graphically for oil, water and CO_2 saturations. This technique eliminates, for practical purposes, uncertainties caused by complex lithology. The results from applying this technique in the Little Knife Field CO_2 Minitest in North Dakota have demonstrated its utility. These results and an in-depth explanation of the technique are presented.

29005 **Dissolution effects of CO_2-brine systems on the permeability of UK and North Sea calcareous sandstones.** Ross, G.D.; Todd, A.C.; Tweedie, J.A.; Will, A.G.S. *Society of Petroleum Engineers of A.I.M.E. (American Institute of Mining, Metallurgical and Petroleum Engineers), Paper;* 149-162(1982). (CONF-820419—).

Dissolution could be a serious problem in the operation of a carbon dioxide flood on a carbonate cemented sandstone. Laboratory core flooding experiments under reservoir conditions demonstrate the effect of the dissolution and the significance of textural properties of the rock. Core flood tests carried out on North Sea core material show similar permeability alteration and effluent concentrations both as a result of channelling and of total dissolution. The presence of residual oil delays the dissolution process. The textural heterogeneity in real rocks make it difficult for existing acidization models to be applied to the interpretation of the laboratory results.

29006 **Investigation of phase behavior-macroscopic bypassing interaction in CO_2 flooding.** Gardner, J.W.; Ypma, J.G.J. *Society of Petroleum Engineers of A.I.M.E. (American Institute of Mining, Metallurgical and Petroleum Engineers), Paper;* 163-196(1982). (CONF-820419—).

CO_2-crude coreflood experiments and high-resolution 2-D CO_2-crude displacement simulations in which viscous fingering is represented explicitly suggest that there is a synergistic interaction between multiple-contact CO_2-crude phase behavior and macroscopic bypassing that causes the ultimate oil recovery (when the system has been swept) to be lower in the unstable case than in the stable case. Assuming this effect is present in field applications of CO_2 flooding, then corefloods in which fingering is absent, for whatever reason, should not be used as direct indicators of field-scale displacement efficiency since they will yield optimistic predictions, all other factors being equal between the laboratory and the field.

29007 **Effects of mobile water on multiple contact miscible gas displacements.** Tiffin, D.L.; Yellig, W.F. *Society of Petroleum Engineers of A.I.M.E. (American Institute of Mining, Metallurgical and Petroleum Engineers), Paper;* 197-215(1982). (CONF-820419—).

This paper presents the effects of mobile water on multiple contact miscible displacements under water-wet and oil-wet conditions. Tests were conducted in 8-foot (244 cm) water-wet and oil-wet Berea cores in which CO_2 and water were injected both separately and simultaneously to displace a reservoir oil. The data presented focus on effects of water in the oil-moving zone where the CO_2 is generating miscibility with the oil and mobilizing residual oil to waterflooding. Special emphasis is placed on understanding the effect of mobile water saturation on the oil displacement efficiency and the component transfer between phases necessary to develop miscibility in the CO_2-reservoir oil system. This study demonstrates that reservoir wettability is a key factor in the performance of AGWIP. Gas-water injection can, under certain conditions, have adverse effects on the characteristics of the oil moving zone. These effects are in part caused by the water trapping portions of the oil and solvent. It was observed that mobile water did not change the mass transfer process by which miscibility develops in a multiple contact miscible displacement. (JMT)

29008 **Three-phase relative permeability measurements using the centrifuge method.** Van Spronsen, E. *Society of Petroleum Engineers of A.I.M.E. (American Institute of Mining, Metallurgical and Petroleum Engineers), Paper;* 217-240(1982). (CONF-820419—).

The centrifuge method for two-phase relative permeability measurements has been extended for use with three mobile phases. The oil and water production obtained from a sample rotated in an air-filled sample holder straightforwardly yields the three-phase oil and water (drainage relative permeabilities along a trajectory in the saturation ternary diagram. The criteria for reliable measurements are discussed. It is shown that these experimental requirements are similar to those for the two-phase case. The extended centrifuge technique has been used for measuring the three-phase oil and water relative permeabilities on Weeks Island and Berea samples. The results of these experiments show that the shape of the oil isoperms in the saturation ternary diagram is concave when viewed from the oil apex. The shape implies a more favorable recovery for immiscible gas (CO_2) injection into the Weeks Island B Sand than predicted on the basis of the convex oil isoperms calculated with the models of Stone or Hirasaki.

29009 **Lumped-component characterization of crude oils for compositional simulation.** Hong, K.C. *Society of Petroleum Engineers of A.I.M.E. (American Institute of Mining, Metallurgical and Petroleum Engineers), Paper;* 241-263(1982). (CONF-820419—).

Compositional simulators using an equation of state to describe the phase behavior of multicomponent fluid mixtures are expensive to use because of the large number of iterative phase equilibrium calculations and large computer storage space required. It is thus desirable to keep the number of components used in describing a fluid mixture to a minimum. This paper describes a method for reducing the number of components without a significant loss of accuracy in describing the phase behavior. Peng-Robinson equation-of-state models with up to five pseudocomponents were developed for three reservoir fluids ranging from a bubble-point to a dewpoint fluid under initial reservoir conditions. These models are shown to match the laboratory-measured phase behavior data almost as accurately as the more complex 14 to 17 component models originally used in reservoir simulation.

29010 **Alvord (3000-ft Strawn) LPG flood: design and performance evaluation.** Frazier, G.D.; Todd, M.R. *Society of Petroleum Engineers of A.I.M.E. (American Institute of Mining, Metallurgical and Petroleum Engineers), Paper;* 265-284(1982). (CONF-820419—).

Mitchell Energy Corporation has implemented a LPG-dry gas miscible process in the Alvord (3000 ft Strawn) Unit in Wise County, Texas utilizing the DOE tertiary incentive program. The field had been waterflooded for 14 years and was producing near its economic limit at the time this project was started. This paper presents the results of the reservoir simulation study that was conducted to evaluate pattern configuration and operating alternatives so as to maximize LPG containment and oil recovery performance. Several recommendations resulting from this study were implemented for the project. Based on the model prediction, tertiary oil recovery is expected to be between 100,000 and 130,000 bbls, or about 7 percent of th oil originally in place in the Unit. An evaluation of the project performance to date is presented. In July of 1981 the injection of a 16% HPV slug of propane was completed. Natural gas is being used to drive the propane slug. A peak oil response of 222 BOPD was achieved in August of 1981 and production has since been declining. The observed performance of the flood indicates that the actual tertiary oil recovered will reach the predicted value, although the project life will be longer than expected. The results presented in this paper indicate that, without the DOE incentive program, the economics for this project would still be uncertain at this time.

29011 **CO_2 injection for tertiary oil recovery, Granny's Creek field, Clay County, West Virginia.** Watts, R.J.; Conner, W.D.; Wasson, J.A.; Yost, A.B. II. *Society of Petroleum Engineers of A.I.M.E. (American Institute of Mining, Metallurgical and Petroleum Engineers), Paper;* 285-307(1982). (CONF-820419—).

Columbia Gas Transmission Corporation, with financial assistance from the US DOE,planned and operated an Enhanced Oil Recovery Project in the Granny's Creek oil field, Clay County, West Virginia. The objective of the field test was to determine the feasibility and economics of recovering additional oil from a (flooded-out) low-oil saturated reservoir using carbon dioxide (CO_2) for miscible displacement of residual oil. CO_2 injection was initiated in early June 1976. Injection was into four corner wells of a normal five-spot. In the initial test, 10,000 tons (9070 t) of CO_2 was injected into the four wells, employing the WAG injection technique for mobility control. Due to pilot pressure distribution, less than 12 percent of the CO_2 entered the pattern. In a second pilot operation phase, a single injection well minitest was initiated within the original CO_2 pilot pattern. Over 2100 tons (1900 t) of CO_2 was injected for this test. Oil production within the pattern during the first phase was over 4000 barrels (640 m^3) with a CO_2/oil ratio of 2500 to 5000 scf/bbl (445 to 890 m^3/m^3). The minitest produced oil at a 17,337 scf/bbls (3100 m^3/m^3) CO_2 utilization rate. It does not appear that the CO_2 miscible displacement process will be economical for tertiary oil recovery in such low-oil saturation reservoirs without better mobility control for greater sweep efficiency. The test results have determined though, that the CO_2 process can mobilize and recover a significant volume of additional oil after waterflooding. (JMT)

29012 **Weeks Island S Sand Reservoir B gravity stable miscible CO_2 displacement, Iberia Parish, Louisiana.** Perry, G.E. *Society of Petroleum Engineers of A.I.M.E. (American Institute of Mining, Metallurgical and Petroleum Engineers), Paper;* 309-327(1982). (CONF-820419—).

Shell, in conjunction with the United States of America Department of Energy, is conducting a gravity stable displacement field test of the miscible CO_2 process. The test is being conducted in the portion of a fault sealed reservoir lying below a subsea depth of -12,750 feet. Injection of the CO_2 slug at the producing gas-oil contact commenced in October 1978. Injection of the 860 MM cubic foot slug was completed in February of 1980. The slug of CO_2 was moved downward through the watered out sand by production of downdip water. The leading edge of teh displacement has reached the producing perforations and production of the oil column commenced on January 26, 1981. Conventional cores and the low-inject-log technique were used to determine residual oil saturation in a well drilled as the pilot producer. Pulsed neutron logging devices have been used to detect the CO_2 slug and monitor its subsequent movements in the vicinity of the production well. The monitor logs indicate the thickness of the oil column had increased during the displacement to the production perforations located 130 feet below the level of CO_2 injection. The 23 foot oil column remaining at initiation of the project had apparently grown to 57 feet. PVT samples and production data indicate CO_2 has penetrated the oil column and free gas is being produced with the oil. However, the qualitative measurements of the logs do not indicate a large gas or CO_2 content in the oil column.

29013 **Enhanced oil recovery by CO_2 miscible displacement in the Little Knife Field, Billings County, North Dakota.** Desch, J.B.; Larsen, W.K.; Lindsay, R.F.; Nettle, R.L. *Society of Petroleum Engineers of A.I.M.E. (American Institute of Mining, Metallurgical and Petroleum Engineers), Paper;* 329-339(1982). (CONF-820419—).

A CO_2 minitest employing the miscible displacement process was conducted in the Mission Canyon Formation (lower Mississippian) at Little Knife Field, North Dakota. The Mission Canyon is a dolomitized carbonate reservoir which is undergoing primary depletion. Four wells were drilled in an inverted four-spot configuration, covering five acres. The central well served as the injection well and was surrounded by three non-producing observation wells. A WAG-type injection sequence utilized five alternate slugs of formation water and CO_2. Preflush injection began December 11, 1980, followed by the WAG slugs from January 7 to March 25, 1981. Drive water injection commenced immediately and was completed on September 24, 1981. Injection rates were maintained at 1150 B/D during water injection and 40 T/D during CO_2 injection. Tracers were used during the waterflood preflush and with the water during the WAG. A pressure core behind the flood front was obtained to confirm residual-oil saturations in the project inter-

val. Overall rock recovery was excellent, 90%, but sample recovery under reservoir pressure was less than anticipated. Invasion of drilling fluids during coring was checked by introduction of a radioactive tracer into the coring fluid. Project analysis is still ongoing and once completed, the simulation models will be updated and used to predict field-wide applicability. (JMT)

29014 **Design and implementation of four enhanced recovery projects in bay fields of south Louisiana.** Boardman, R.S.; Moore, L.J.; Julian, M.H.; Bilbrey, D.G.; Moore, J.S. *Society of Petroleum Engineers of A.I.M.E. (American Institute of Mining, Metallurgical and Petroleum Engineers), Paper;* 341-355(1982). (CONF-820419—).

This paper reviews the design and implementation of four enhanced recovery projects that were initiated in the shallow-water environment of two bay fields located along the coastline of South Louisiana. These four projects are a caustic augmented waterflood, a miscible carbon dioxide waterflood, both in Quarantine Bay Field, and two polymer augmented waterfloods in the West Bay Field. The paper focuses on the design modifications required for the projects due to the hostile overwater environment and the logistics problems associated with the locations of the projects.

29015 **Enhanced oil recovery from offshore Gulf of Mexico reservoirs.** Brashear, J.P.; Morra, F. Jr.; Haas, M.R.; Payne, S. *Society of Petroleum Engineers of A.I.M.E. (American Institute of Mining, Metallurgical and Petroleum Engineers), Paper;* 357-365(1982). (CONF-820419—).

More than eight billion barrels of oil will remain in Gulf of Mexico reservoirs at the end of primary and secondary operations. This study is designed to determine whether a portion of this can be produced by enhanced oil recovery (EOR) methods. All oil reservoirs with more than 2.5 MMB original oil-in-place in the Federal Offshore region of the Gulf of Mexico were screened by geological criteria to determine general amenability to EOR. One hundred seventh-six individual reservoirs, in 100 horizons (hear adjacency at comparable depth), were identified. In all, 40 fields had one or more geologically acceptable horizons. This paper describes the characteristics of these reservoirs and projects the timing of their abandonment. The prospective reservoirs are currently undergoing detailed technical and economic evaluation. The paper also includes this evaluation for example reservoirs.

29016 **Enhanced oil recovery in Rumania.** Carcoana, A.N. *Society of Petroleum Engineers of A.I.M.E. (American Institute of Mining, Metallurgical and Petroleum Engineers), Paper;* 367-379(1982). (CONF-820419—).

The wide oil field experience of the Romanian oil men in producing hydrocarbon reservoirs is based on an old tradition, but only after 1945 reservoir engineering studies were started in Romania. Beginning with 1950 conventional recovery methods expanded continually. During the last 10 years, however, the crude oil, as energy resource, has become of tremendous importance. The need for increasing the ultimate oil recovery has been felt in Romania as everywhere else. To attain this goal EOR methods were and are tested and expanded on a commercial scale. The paper describes the application of the fire-floods to a broad range of Romanian oil reservoirs and crude properties and reviews the field tests of polymer flooding, surfactant flooding and alkaline flooding. A commercial scale project with cyclic steam injection is presented and also the use of the domestic CO_2 sources to enhance oil recovery. The results and the diffuculties encountered are briefly discussed and also the potential of EOR methods in Romania are presented.

29017 **Chemical enhancement of oil production by cyclic steam injection.** Blair, C.M. Jr.; Scribner, R.E.; Stout, C.A. *Society of Petroleum Engineers of A.I.M.E. (American Institute of Mining, Metallurgical and Petroleum Engineers), Paper;* 381-389(1982). (CONF-820419—).

Members of a special class of interfacially active chemicals were injected into wells in Kern County, CA, immediately before and during the huff'n'puff steaming cycle. Water and oil production rates were determined during the subsequent production cycles and compared with the rates observed during the preceding steam-only production cycles of the same wells. The chemical treatment was found to give significant increases in oil production.

29018 **Preliminary study of in-situ combustion in diatomites.** Fassihi, M.R.; Abu-Khamsin, S.; Brigham, W.E.; Williams, L.A.; Graham, S.A. *Society of Petroleum Engineers of A.I.M.E. (American Institute of Mining, Metallurgical and Petroleum Engineers), Paper;* 391-408(1982). (CONF-820419—). Contract AC03-76ET12056.

In order to test the feasibility of applying in-situ combustion techniques to diatomaceous reservoirs, a laboratory test was conducted for a section of core taken in the south plunge of the anticline in the Lost Hills field of the San Joaquin Valley in California. Tests were conducted to compare the cores before and after combustion, using scanning microscopy, powder x-ray diffraction, and extraction techniques. After burning, the sediments changed from dark brown to red in color as a result of oxidation of organic and iron phases. Small numbers of diatom frustules were transformed from amorphous opol to quartz, with accompanying occlusion of pore spaces. With the exception of the color change, however, the sediments remained largely unaltered. It is especially interesting to note that the kerogen within the sediments appears to supply a portion of the fuel required for combustion. Kerogen is detrital organic matter than can be burned but cannot be extracted easily from a core in the laboratory. Kerogen's presence could make in-situ combusion more economical and efficient than other EOR methods in diatomites. (JMT)

29019 **Method of measuring steam quality and heat loss in distribution and downhole piping.** Pradt, L.A. *Society of Petroleum Engineers of A.I.M.E. (American Institute of Mining, Metallurgical and Petroleum Engineers), Paper;* 409-415(1982). (CONF-820419—).

This paper describes a technique that can be used to determine the steam quality in the outlet of a once-through steam generator. The technique can also be used to measure the heat loss between any two points in a distribution and downhole piping system. The technique is based on the fact that a mixture of a vapor and a non-condensible gas condenses along a dwew point curve, instead of at constant temperature as in the case of a pure vapor.

29020 **Comparative evaluation of surface and downhold steam generation techniques.** Hart, C.M. *Society of Petroleum Engineers of A.I.M.E. (American Institute of Mining, Metallurgical and Petroleum Engineers), Paper;* 417-432(1982). (CONF-820419—). Contract AC04-76DP00789.

The objective of the Department of Energy's Project DEEP STEAM is to develop the technology required to economically produce heavy oil from deep reservoirs. The tasks included in this effort are the development and evaluation of thermally efficient delivery systems and downhole steam generation systems. This paper compares the technical and economic performance of conventional surface steam drives, which are strongly influenced by heat losses, with (a) thermally efficient delivery (through insulated strings) of surface generated steam, (b) low pressure combustion downhole steam generatjion, (c) high pressure combustion downhole steam generation using air as the oxygen source, and (d) high pressure combustion downhole steam generation substituting pure oxygen for air. The selection of a preferred technology based upon either total efficiency or cost is found to be strongly influenced by reservoir depth, steam mass flow rate, and sandface steam quality. Therefore, a parametric analysis has been performed which examines varying depths, injection rates and steam qualities. Results indicate that the technologies are not readily distinguishable for low injectivity reservoirs in which conventional steam drives are feasible. However, high injection rates produce a notable cost difference between high pressure combustion systems and the other technologies. Issues that must be addressed before gaining further insight into the economic viability of downhole steam generatjion are discussed. (JMT)

29021 **Direct-fired downhole steam generator: from design to field test.** Schirmer, R.M.; Eson, R.L. *Society of Petroleum Engineers of A.I.M.E. (American Institute of Mining, Metallurgical and Petroleum Engineers), Paper;* 433-440(1982). (CONF-820419—).

A direct-fired downhole steam generator (DFDSG) has been developed which shows considerable promise for production of

heavy oil. Generation of steam by surface boilers is inefficient because of heat losses, and air pollution curtails crude production. The technology of DFDSG is very attractive because it deals with both of these problems directly, and there are additional benefits. By carrying out the combustion process at high pressure, and then adding water, a mixture of carbon dioxide, nitrogen, and steam is charged directly into the heavy oil reservoir. This eliminates the need for expensive, and inefficient, stack scrubbers to remove sulfur dioxide, as well as sophisticated NO/sub x/ control techniques. The carbon dioxide created during the fuel burning process is absorbed by the heavy oil and increases its mobility without expending additional energy. Even the nitrogen contributes a high-velocity drag which increases both crude production rate and efficiency. DFDSG offers the potential for placing into the production zone, regardless of its depth, any quality effluent desired, from wet to superheated steam.

29022 **Laboratory investigation of the oxygen combustion process for heavy oil recovery.** Moss, J.T.; Cady, G.V. *Society of Petroleum Engineers of A.I.M.E. (American Institute of Mining, Metallurgical and Petroleum Engineers), Paper;* 441-454(1982). (CONF-820419—).

The laboratory investigations were conducted using core material and produced oil from a typical Alberta heavy oil reservoir. The experiments established combustion characteristics using air and the Combination Thermal Drive (CTD) process for thermal oil recovery. Both the combustion and CTD tests indicated the oil's favorable response to thermal recovery. The results of laboratory studies using oxygen and oxygen with water injection have indicated that the enriched air process, as Ramey suggested almost thirty years ago, is not only viable as an oil recovery method, but the process is also highly desirable.

29023 **Study of Getty Oil Co.'s successful in-situ combustion project in the Bellevue Field.** Long, R.E.; Nuar, M.F. *Society of Petroleum Engineers of A.I.M.E. (American Institute of Mining, Metallurgical and Petroleum Engineers), Paper;* 481-486(1982). (CONF-820419—).

The in situ combustion project operated by Getty Oil Company in the Bellevue Field, Bossier Parish, Louisiana, has expanded from a single pilot pattern in 1963 to a full-scale operation with more than one hundred patterns in 1981. Originally discovered in 1921, the field produced for about ten years under primary production methods. The field remained relatively dormant until Getty Oil Company conducted a successful in situ combustion pilot which commenced in 1963. The project is now producing about 2900 barrels daily of 19.5° API gravity crude from 350 producing wells. Pattern sizes and configurations have varied during the eighteen year project. West and dry combustion methods have been used in the field and a combination of the two methods is used today depending on the stage of burn the pattern is experiencing. Several water-air injection ratios have been tried with varying degrees of success. In this paper, Getty's Bellevue project is traced from its inception to the present. Response to various methods used in the field as well as operational problems are discussed. Ultimate production forecasts are also presented for the field.

29024 **Development of the in-situ combustion process on an industrial scale at Videle field, Rumania.** Turta, A.T.; Pantazi, I.G. *Society of Petroleum Engineers of A.I.M.E. (American Institute of Mining, Metallurgical and Petroleum Engineers), Paper;* 487-495(1982). (CONF-820419—).

The Sarmatian 3 Videle field is among the biggest heavy oil reservoirs presently known in the world (oil viscosity under reservoir conditions ranges from 30 to 120 cP). There are two producing horizons, namely Sarmatian 3 a+b partially overlying Sarmatian 3 c. The field was discovered in 1959. During the period 1964-1976 a water injection project was gradually expanded to the whole reservoir area. The average oil recovery is, at the present time, of about 13% and the producing wells are approaching the economic limit - the producing oil-water ratio is higher than 25. For this reason it was decided to study the feasibility of producing the field by in-situ combusion to recover additional tertiary oil. To obtain the necessary data three field combustion pilots, located upstructure in various areas of the reservoir, are being operated. The performance of the three tests is presented and discussed. The favorable results obtained so far justify the full-scale application of the in-situ combustion process. A line drive scheme has been selected, so that a more or less continuous combustion front will move downdip. To supply the necessary air for a combustion front of more than 18 km(11.2 miles) in length a giant compression capacity of about 7,000,000 sm^3/d (247,203,000 SCF/d) will be required.

29025 **Analysis of the early performance of the M-6 steam-drive project, Venezuela.** Schenk, L. *Society of Petroleum Engineers of A.I.M.E. (American Institute of Mining, Metallurgical and Petroleum Engineers), Paper;* 497-521(1982). (CONF-820419—).

Since January 1978 Maraven has been conducting the M-6 Steam Drive Project in Tia Juana, one of the Bolivar Coast Heavy Oil Reservoirs near Lake Maracaibo. The project is carried out on a semi-open seven-spot well configuration, using the existing 231-m grid and comprises at present 21 injectors and 130 producers. The project area is 7.4 km^2, depth 1800 ft ss, and originally contained 525 million bbl of 13 degr. API Crude. The recovery by primary depletion, enhanced by steam soak, was 22 % STOIIP at the start of steam drive. Steam is supplied by a plant with a nominal capacity of 10,000 t/d of saturated, dry steam at 1000 psig. Lake Maracaibo water softened by ion-exchange is used as feed water and natural gas as fuel. Following a build-up period of 6 months the steam injection rate has ranged between 6000 and 8500 t/d, averaging 7400 t/d up to the end of 1981, at well head pressures of around 500 psig. The oil production increased from a pre-project level of 8000 b/d to 18,000 to 23,000 b/d since early 1980, accompanied by an increase in water production from 4000 up to 40,000 b/d. Cumulative performance data for the period January 1978 to December 1981 are: steam injected 10.2 million tons, oil produced 23.7 million bbl, extra oil produced 15.9 million bbl and water produced 33.0 million bbl. Corresponding main project parameters are: cumulative oil production 4.5% STOIIP, of which 3% STOIIP is extra, oil/steam ratio 2.3 bbl/ton, extra-oil/steam ratio 1.6 bbl/ton. (JMT)

29026 **New polymer for enhanced oil recovery.** Bauer, R.G.; Klemmensen, D.F. *Society of Petroleum Engineers of A.I.M.E. (American Institute of Mining, Metallurgical and Petroleum Engineers), Paper;* 523-536(1982). (CONF-820419—).

A new water soluble acrylic polymer has been developed for use as a mobility control agent in enhanced oil recovery. This polymer was designed to meet the fundamental requirements for a mobility control application, including cost effectiveness, stability to mechanical shear, non-plugging in porous media, demonstrable tertiary oil recovery, stability in the presence of salts and chemicals, and retention of viscosity after extended exposure to elevated temperatures. This polymer has been extensively tested in the laboratory and compared to existing mobility control polymers, such as partially hydrolyzed polyacrylamides and polysaccarides. One of the major attributes that this polymer demonstrated was a retention of viscosity after extended aging at elevated temperatures in various media, including high brine conditions. Laboratory core floods have shown this polymer to be equally effective in tertiary oil recovery in both polymer-augmented waterfloods and caustic-polymer waterfloods when compared to commercial partially hydrolyzed polyacrylamides. This new polymer is available in a liquid form (latex) and does not contain any hydrocarbon vehicle, such as those present in inverse-emulsion polyacrylamides. (JMT)

29027 **Elimination of xanthan microgels by new enzymatic treatments.** Kohler, N.; Milas, M.; Rinaudo, M. *Society of Petroleum Engineers of A.I.M.E. (American Institute of Mining, Metallurgical and Petroleum Engineers), Paper;* 537-557(1982). (CONF-820419—).

Previously proposed enzymatic procedures for clarifying aqueous xanthan-gum solutions, based on alkaline proteases, have two serious limitations (i.e., low salt and hardness tolerances and the incapacity to eliminate microgels) which have recently been found to be the cause of drastic plugging phenomena. These limitations can be effectively overcome by subjecting raw xanthan-gum solutions to the action of polysaccharide hydrolases, also called polysaccharases. Under well defined experimental conditions, the viscosities of polysaccharide solutions remain unaffected, and the amounts of both insoluble materials and microgels are considerably

reduced. Experiments succeed even where salinity and bivalent ion levels are high. Both fermentation broths and xanthan powders can be treated. Where microgel levels are very high, a synergic effect is obtained by using both polysaccarase and protease treatments, either successively or simultaneously. The effectiveness of this combination of enzymes makes it possible to use xanthan powders, which have heretofore been considered unsuitable because of their limited injectability. Some preliminary results concerning a scheduled field application of this process are also described.

29028 **Interpretation of differential pressure in laboratory surfactant/polymer displacements.** McCool, C.S.; Parmeswar, R.; Willhite, G.P. *Society of Petroleum Engineers of A.I.M.E. (American Institute of Mining, Metallurgical and Petroleum Engineers), Paper;* 559-585(1982). (CONF-820419—).

Experimental data were obtained for two surfactant/polymer systems in which fluid mobilities and mobility control were studied through the analysis of differential pressure measurements. One system used nonane as the hydrocarbon phase while the other system used crude oil from the Madison Field, Greenwood County, Kansas. Movement of fluid regions through the core was inferred from the differential pressure measurements along the core. In the nonane system, similar pressure perturbatjions at the ports were extrapolated linearly to the end of the core and correlated with effluent phase production. The microemulsion surfactant slug changed to a more mobile macroemulsion within the first half of the displacement. This macroemulsion moved through the last half of the core as a stabilized, constant velocity bank indicating good mobility control even though the apparent viscosity of the macroemulsion was less than that of the stabilized oil/water banks. In the crude oil surfactant system, pressure data collected along the core indicated capillary pressure effects at the leading edge of the oilbank and the formation of a viscous, less mobile region due to mixing of the microemulsion slug with resident fluids. Phase behavior studies indicated the formation of a viscous lower phase as the microemulsion was diluted with brine. The formation and propagation of this viscous region during displacement leads to favorable mobility control illustrated by the pressure mobility curves as well as by good oil recoveries (80 to 95%).

29029 **Mobilization and banking of residual oil in high salinity reservoir systems with the use of aqueous surfactant solutions of ethoxylated carboxymethylates.** Kraft, H.R.; Pusch, G. *Society of Petroleum Engineers of A.I.M.E. (American Institute of Mining, Metallurgical and Petroleum Engineers), Paper;* 587-609(1982). (CONF-820419—).

Highly saline reservoir brine and crude oil with ethoxylated carboxymethylates and cosolvents show a complication phase behavior. The phase inversion temperature (PIT) has been investigated with respect to its ability to discern phase transformation in oil-brine-surfactant systems. PIT proved to be very sensitive to changes in salinity, ionic strength, water-oil ratio and surfactant concentration, which simultaneously are responsible for phase inversion of chemical systems in the porous medium. Viscosity measurements on the emulsion in a low shear viscosimeter demonstrated that the increase of viscosity of a water-in-oil emulsion can be attributed to the increase of the WOR. In displacement processes this may be provoked by viscous finering of the mobility buffer into the mobilized oil bank. The length and profile of the oil bank is controlled by phase conditions and viscous forces in the transition zone of the mobility buffer. By addition of a suitable alcohol as a cosolvent to the surfactant slug or to the mobility buffer the temperature range of the stable displacement process could be extended without loss of recovery efficiency and the pressure gradients observed during the flood were in the normal range.

29030 **Multiple slug scaling of linear and pattern laboratory chemical floods.** Haskin, H.K.; Davis, L.A. *Society of Petroleum Engineers of A.I.M.E. (American Institute of Mining, Metallurgical and Petroleum Engineers), Paper;* 611-650(1982). (CONF-820419—).

Linear floods were conducted in a synthetic water-wet matrix. The multiple slug scaling approach used oil saturation distributions measured by microwave attenuation in one laboratory flood to predict accurately the tertiary residual oil saturation and tertiary oil breakthrough in another laboratory linear flood run with larger slug sizes. Oil saturation distributions at 0.11 V/V/sub p/ intervals during the flood, as well as at S/sub orc/, were also accurately predicted. A laboratory quarter five-spot pattern flood involving sequential injection of a small surfactant slug, a small polymer slug, and continuous drive water was run in a water-wet synthetic matrix. Linear flood oil saturation distributions were scaled to predict the oil saturation distributions in the pattern using a fixed twelve streamtube model for the flow. Details of this scaling procedure are given. Residual tertiary oil saturation, tertiary recovery, and oil saturation changes with time were predicted to within the experimental errors involved in the procedures. The observed tertiary oil breakthrough was later than predicted. Observed oil saturation distributions tended to show more oil left in the corners of the model than predicted by the scaling theory. These secondary effects and the overall behavior of the pattern flood are considered in terms of the chosen streamtube network and the assumptions of stable unit mobility flow. (JMT)

29031 **Model for interfacial activity of acidic crude oil-caustic systems for alkaline flooding.** Ramakrishnan, T.S.; Wasan, D.T. (Illinois Inst. of Tech., Chicago). *Society of Petroleum Engineers of A.I.M.E. (American Institute of Mining, Metallurgical and Petroleum Engineers), Paper;* 651-667(1982). (CONF-820419—). Contract AC19-79BC10069.

The interaction of the alkali in flood water and the acids in reservoir crude results in the in situ formation of surfactants, which are responsible for the lowering of interfacial tension (IFT) in caustic flooding. The extent ot which IFT is lowered depends on the specific properties of the crude oil and the injection water. Therefore, it is important to establish the relationship between IFT and the essential chemical properties of the acidic oil and the flood water. This paper presents such a relationship. In this discussion, the adsorption and the desorption of the active species at the interface are modeled as ionic processes using the Gouy-Chapman theory of the diffuse double layer. The interfacial potentials calculated using this model show a fair agreement with the experimentally measured trend of electrophoretic mobility. Also, the model rationalizes the experimentally observed effects of alkali concentration, salinity and the oleic to aqueus phase ratio on IFT. It is concluded that the acid number of the crude oil may not directly correlate with interfacial activity. Even in cases of low acid number crudes, significant interfacial activity could be obtained because of highly hydrophobic active species in the crude.

29032 **North Burbank Unit 1440-acre polymer flood project design.** Trantham, J.C.; Moffitt, P.D. *Society of Petroleum Engineers of A.I.M.E. (American Institute of Mining, Metallurgical and Petroleum Engineers), Paper;* 669-688(1982). (CONF-820419—).

Substantial areas of the North Burbank Unit, Osage County, Oklahoma, gave poorer than average response to waterflooding. After studies showed that the performance of these areas could be traced to greater than field average heterogeity, a pilot polymerflood was conducted during the period from 1970 to 1979. Good response to polymerflooding, followed by economic evaluation of proposed expanded operations, led to the design and implementation of a 1440 acre commercial scale project. The project involved injection of fresh water preflush during the period from September, 1980 to late April, 1981. Then a liquid emulsion type polyacrylamide was blended to 500 ppM in fresh water and injected at a total rate of 63,000 BPD until approximately 4.4 percent of the pore volume had been injected. This was followed by a water spacer, and a 0.8 percent (PV) slug of aluminum citrate containing 500 ppM of aluminum was injected as a cross-linking agent into those two-thirds of the injectors which were expected to present no injectivity problems. Following injection of a second water spacer, 500 ppM polymer injection was resumed. Plans call for injection of polymer at 500 ppM until the total amount reaches 15 percent of pore volume. This will be followed by polymer slugs of 250 ppM (10 percent of pore volume) and 50 ppM (15 percent of pore volume), fresh water (20 percent of pore volume), and finally drive (produced) water. Any localized channeling problems will be handled by treating individual injecgtion wells with crosslinking agents such as aluminum citrate. Methods of scaling up pilot results to the 1440-acre commercial project, site selection, design of the fresh

water preflush, estimation of aluminum citrate requirements, and project costs are discussed.

29033 **Isenhour unit: a unique polymer-augmented alkaline flood.** Sloat, B.; Zlomke, D. *Society of Petroleum Engineers of A.I.M.E. (American Institute of Mining, Metallurgical and Petroleum Engineers), Paper;* 689-715(1982). (CONF-820419—).

The history of the enhanced recovery work on the Isenhour oil field in Sublette County, Wyoming is discussed. The geology of the field is briefly mentioned, and the problems involved in selecting the flooding agent is detailed. Techniques were used to improve the sweep and alkaline agents were used to lower oil saturation simultaneously. (JMT)

29034 **Alkaline flood prediction studies, Ranger VII pilot, Wilmington Field, California.** Mayer, E.H.; Breit, V.S. *Society of Petroleum Engineers of A.I.M.E. (American Institute of Mining, Metallurgical and Petroleum Engineers), Paper;* 717-740(1982). (CONF-820419—).

The design of a simulator to model alkaline displacement mechanisms is discussed and the current state-of-the-art understanding of in-situ caustic consumption is reviewed. Laboratory core flood and rock consumption data are used in one- and two-dimensional limited area simulations and in a three-dimensional model of the entire Wilmington Field pilot project. Simulation studies of alkaline flood behavior in a small two-dimenstional area of the field for various concentrations, slug sizes, long term consumption functions, and two relative permeability adjustment mechanisms are given. Additional application of the simulator methods developed in the pilot and in other alkaline floods are recommended. (JMT)

29035 **In-situ combustion in naturally fractured heavy oil reservoirs.** Schulte, W.M.; de Vries, A.S. *Society of Petroleum Engineers of A.I.M.E. (American Institute of Mining, Metallurgical and Petroleum Engineers), Paper;* 741-762(1982). (CONF-820419—).

Experiments are described which show that the burning process is governedby diffusion of oxygen from the fractures into the matrix. The main oil-production mechanisms were found to be thermal expansion and evaporation with subsequent condensation of the oil in the matrix. A semi-two-dimensional numerical simulator has been constructed for modelling the process. It incorporates the main physical mechanisms as found in the experiments; heat losses to cap or base rock and gravitational effects are not included. The model predicts that in-situ combustion in fractured reservoirs is feasible and will have a high recovery efficiency in the swept zone. Oxygen breakthrough was observed when the air-injection rate exceeded a critical value predominantly determined by the fracture spacing. This phenomenon and also the shape and width of the combustion zone can be explained by a simple analytical model which is in fair agreement with the simulator results. The effect of heat losses on the velocity of the combustion front is estimated and a lower bound for the injection rate can be obtained in this way. Combining this lower bound with the upper bound for oxygen breakthrough leads to a maximum value for fracture spacing. In most cases this distance will be of the order of one metre. The conclusion is that in-situ combustion appears to be a feasible process in a naturally fractured reservoir with a high recovery in the swept zone. However, for predictions for a particular reservoir, vertical sweep efficiency should be taken into account.

29036 **Performance of DOE's micellar-polymer project in northwest Oklahoma.** Thomas, R.D.; Spence, K.L.; Burtch, F.W.; Lorenz, P.B. (Dept. of Energy, Bartlesville, OK). *Society of Petroleum Engineers of A.I.M.E. (American Institute of Mining, Metallurgical and Petroleum Engineers), Paper;* 763-781(1982). (CONF-820419—).

DOE's Bartlesville Energy Technology Center has completed a micellar-polymer flood in the Delaware-Childers Field in NE Oklahoma. The producing horizon was the oil-wet Bartlesville sandstone, at a depth of 620 to 700 ft., which has a net pay thickness of 52 ft, an average permeability of 100 md, and an average porisity of 21 percent. Estimated oil saturation was 32 to 36 percent of 33° API gravity oil. Injection of the approximately 0.1 PV of micellar fluid was started April 28, 1976, following five months of brine preflush. Micellar injection was completed and polymer injection started October 5, 1976. Injection of the approximately 0.4 PV of polymer was completed in August 1979 and fresh water injection started. Pressure and flow for the injection wells were monitored instrumentally. Spot checks for the quality of injected and produced fluids were made by chemical analysis. The project was not technically or economically a success, but did provide much information that is proving useful in other similar projects. A small amount of tertiary oil was produced by the micellar-polymer system.

29037 **Equilibrium phase compositions of CO_2-crude oil mixtures: comparison of continuous multiple contact and slim tube displacement tests.** Orr, F.M. Jr.; Silva, M.K.; Lien, C.L. *Society of Petroleum Engineers of A.I.M.E. (American Institute of Mining, Metallurgical and Petroleum Engineers), Paper;* 783-802(1982). (CONF-820419—).

Results of phase composition and density measurements for CO_2-crude oil mixtures at 32°C and four pressures are reported for a system in which liquid-liquid and liquid-liquid-vapor phase separations occur. The experiments demonstrate that a CO_2-rich liquid phase can contain as much as 30 weight percent hydrocarbons and show that a CO_2-rich vapor phase at the same conditions extracts hydrocarbons less efficiently. Pseudo-ternary phase diagrams are presented which summarize the results of the detailed phase composition measurements. Results of slim tube displacements at the same four pressures are also given. They indicate that displacement is efficient when the pressure is high enough that a liquid CO_2-rich phase appears. Predictions of the performance of the slim tube displacements based entirely on the experimental measurements of phase compositions and densities are obtained using a simple one-dimenstional simulator. The simulation results clarify the roles of phase behavior and volume change on mixing in the slim tube tests. Finally, a comparison of the advantages and limitations of the slim tube and continuous multiple contact tests is given. We conclude that the continuous multiple contact experiment yields more information useful for prediction of the performance of a CO_2 flood.

29038 **Equilibrium phase compositions of CO_2-hydrocarbon mixtures: measurement by a continuous multiple contact experiment.** Orr, F.M.; Silva, M.K. *Society of Petroleum Engineers of A.I.M.E. (American Institute of Mining, Metallurgical and Petroleum Engineers), Paper;* 803-816(1982). (CONF-820419—).

A new experimental technique which measures simultaneously compositions and densities of two phases in equilibrium is described. Because it operates continuously, the experiment can be performed more rapidly than conventional static equilibrium measurements. Details of the experimental apparatus are reported, and results of test displacements for two simple CO_2-hydrocarbon systems are compared with static equilibrium phase composition measurements for the same systems. A simple analysis of the operation of the experiment is used to assess the experimental error which results from the continuous nature of the experiment and to suggest ways to reduce that error. Application of the experimental technique to a CO_2-crude oil system is reported in a companion paper.

29039 **Slaughter Estate Unit CO_2 pilot reservoir description via a black oil model waterflood history match.** Ader, J.C.; Stein, M.H. *Society of Petroleum Engineers of A.I.M.E. (American Institute of Mining, Metallurgical and Petroleum Engineers), Paper;* 817-837(1982). (CONF-820419—).

Amoco Production Company is conducting a tertiary miscible gas pilot in the Slaughter Estate Unit, Hockley County, Texas. The pilot consists of two normal five-spot patterns which encompass an area of 12.3 acres (49.8 Mm^2) and is located in a region of the unit that is undergoing an active waterflood. The pilot wells were drilled in 1972 in an area of the unit that was under volumetric depletion. A pilot waterflood was then initiated in November 1972. A well-established secondary decline was obtained in the pilot in 1976 and acid gas (72% CO_2 and 28% H_2S) was then initiated. The pilot objectives are to determine primary plus secondary and tertiary oil recovery and to obtain a quantitative interpretation of the acid gas displacement process. A good reservoir description is required to meet these objectives since the tertiary performance

is influenced by both reservoir heterogeneities and variables associated with the acid gas displacement process. It was determined that the Slaughter Estate Unit tertiary pilot had an original oil-in-place of 642,400 STB (102 133 m^3). A waterflood prediction using the reservoir description described in this paper indicates that an ultimate primary plus secondary recovery of 48.8% OOIP would have been obtained from the pilot if waterflood operations had been continued to an abandonment water cut of 98%. Based on this prediction, it was established that the tertiary oil recovery due to the miscible acid gas process was 15.5% OOIP as of October 21, 1981 (JMT)

29040 **Equilibrium of a microemulsion that coexists with oil or brine.** Huh, C. *Society of Petroleum Engineers of A.I.M.E. (American Institute of Mining, Metallurgical and Petroleum Engineers), Paper;* 839-870(1982). (CONF-820419—).

When salinity, or an equivalent variable, is increased, microemulsions generally undergo orderly transitions from a lower-phase state (water-external spherical micelles) to middle-phase (hydrophile and lipophile almost balanced, but structural details unknown) to upper-phase (oil-external spherical micelles). The hydrophile-lipophile-balanced microemulsion thus obtained has the capability to solubilize a large amount of oil, produce low interfacial tensions, and show good oil recovery. Even though the significance of achieving such a balance has been well recognized in the design of surfactant systems, its quantitative nature in terms of the molecular structures of the surfactant lipophile, hydrophile and the oil and brine salinity has not been fully understood. As part of an experimental-theoretical program to delineate the above relations, our objective is to provide within a single framework a theory that will comprehend all three microemulsion states and put the hydrophile-lipophile-balanced state in its proper perspective. While the theory developed in this report does not accomplish this goal, it is a step in this direction in that it properly describes the lower-phase and upper-phase states, and offers a possibility of being able to describe the hydrophile-lipophile-balanced state in terms of the tendency of surfacetant layer at the oil/brine interface to bend toward either the oil or brine phase.

29041 **Study of the oil wedge phenomenon through the use of chemical flood simulator.** Tham, M.J.; Nelson, R.C.; Hirasaki, G.J. *Society of Petroleum Engineers of A.I.M.E. (American Institute of Mining, Metallurgical and Petroleum Engineers), Paper;* 871-889(1982). (CONF-820419—).

The presence of an oil wedge in some of the core flood experiments indicates possible inefficient use of the expensive surfactant mixture. The oil wedge problem has been studied in some detail by means of a chemical flood simulator. Knowledge gained from this study will be useful in the design of future field-scale chemical floods. The formation of an oil wedge in a chemical flood is due to an unfavorable gravity override condition at the front of the surfactant bank and gravity underrun at the back side of the surfactant bank and to the limited availability of surfactant in the flood. Chemical flooding systems which are Type III over a broad salinity range are less likely to form an oil wedge than systems which are Type III over narrow salinity range. The gravity override condition at the front of the surfactant bank may be improved by designing a broad salinity range and which has a high Type II(+) boundary on the salinity requirement diagram. The gravity override condition can also be improved by preceding the chemical slug with a low salinity preflood or by lowering the chemical slug salinity. The unfavorable gravity underrun condition at the back side of the surfactant bank can be improved by increasing the injection rate, by increasing the drive viscosity, by lowering the chemical slug salinity or by designing a better chemical flooding system which has a broad Type III salinity range.

29042 **Evaluation of a conventional steam drive with ancillary materials: North Kern Front Field.** Eson, R.L.; O'Nesky, S.K. *Society of Petroleum Engineers of A.I.M.E. (American Institute of Mining, Metallurgical and Petroleum Engineers), Paper;* 891-900(1982). (CONF-820419—).

A steam foam solution and a steam foam encapsulated in a polymer gel are being introduced in four steam injection patterns in the North Kern Front Field near Bakersfield, California. The ability of the ancillary materials to improve recovery will be determined through injection profiles, chemical tracer surveys, casing vent gas analyses, core and log data and residual oil saturation data, as well as through temperature and production monitoring. It has been shown that in-situ steam foams can be used to alter the steam injection profiles to prevent excessive steam channeling. Results after injection of ancillary materials for approximately 18 months indicate that improvements in both the areal and vertical sweep efficiencies have been found in the four treated patterns when compared to the untreated control patterns. Several techniques are still under evaluation to determine the exact amount of incremental oil produced. Discussion of production response will be limited to two of the four treated patterns, Witmer B2-3 and Witmer B2-5. A comparison of these two patterns to the Witmer control pattern, Witmer A2-7, indicates approximately 52 B/D (8 mv/d) of incremental oil is being produced as a result of the weekly chemical treatments.

29043 **Critical scaling behavior of microemulsions.** Huang, J.S.; Kim, M.W. *Society of Petroleum Engineers of A.I.M.E. (American Institute of Mining, Metallurgical and Petroleum Engineers), Paper;* 901-909(1982). (CONF-820419—).

Dynamic light scattering was employed to study the characteristic droplet size, a, in dilute single phase microemulsions near the critical phase transition point. It was found that there existed a general power-law dependence of a on the reduced variable ΔZ = absolute value Z/sub c/-Z. Here Z stands for any thermodynamic and system variables whose critical value is denoted by Z/sub c/. The variables of interest in the present work are temperature and alkane carbon number. It is found that a proportional to ΔZ^{-}/sup - nu/ where nu = 0.75 +- 0.1. This is observed both in water-internal and oil-internal microemulsions, independent of the surfactant properties. This behavior, known as the scaling behavior, was analyzed in terms of generalized homogeneous functions with nu as the degree of homogeneity. It turns out that only one of the reduced variables is an independent variable in these functions, thus greatly simplifying the description of the properties of microemulsions in the neighborhood of a critical phase boundary.

29044 **Interfacial light scattering study in microemulsions.** Kim, M.W.; Huang, J.S.; Bock, J. *Society of Petroleum Engineers of A.I.M.E. (American Institute of Mining, Metallurgical and Petroleum Engineers), Paper;* 911-920(1982). (CONF-820419—).

Thermally excited waves at the interface between two fluids contain information about the structure and tension at this interface. A surface light scattering technique based on photon correlation spectroscopy has been developed ot probe the dynamics of these interfacial waves for microemulsions. The interfacial tension (IFT) as measured by this non-perturbing technique is consistent with the values obtained by conventional methods. The temperature and salinity dependence of γ, (IFT), in a 3-phase microemulsion system was studied and it was found that $\gamma \sim \epsilon^{2\nu-0.5}$, where ϵ is the reduced variable absolute value Tc-T and absolute value Sc-S with Tc and Sc representing the critical values of temperature and salinity, respectively. Furthermore, the correlation length, a, in the microemulsion phase has also been measured by dynamic light scattering. In the two phase regions it was observed that $\gamma \sim a^{-3}$, in accordance with the scaling law predictions. Thus the scaled salinity and temperature parameters influence the interfacial tension through their effect on the correlation length in the bulk microemulsion phase.

29045 **Experimental studies of in-situ microbial enhanced oil recovery.** Jenneman, G.E.; Knapp, R.M.; McInerney, M.J.; Menzie, D.E.; Revus, D.E. (Univ. of Oklahoma, Norman). *Society of Petroleum Engineers of A.I.M.E. (American Institute of Mining, Metallurgical and Petroleum Engineers), Paper;* 921-931(1982). (CONF-820419—).

The goal of this research is to study the feasibility of using microorganisms in the enhanced recovery of oil. The use of microorganisms requires the ability to transport viable cells as well as the nutrients necessary for cell growth through reservoir formations. Glucose, peptone-protein, and phosphate and ammonium ions were transported through brine saturated Berea sandstone cores in amounts sufficient to support cell growth. Viable bacterial cells

have been transported through sandstone cores of 170 to 490 md permeabilities. The addition of nutrients to these cores and subsequent cell growth caused permeability reductions of 60 to 80%. In addition, a microorganism has been obtained which during growth produces a surfactant that lowers the surface tension of 5% NaCl brine to 27 mN/m and the interfacial tension against crude oil to less than 1.0 mN/m.

29046 **Loudon surfactant flood pilot test.** Bragg, J.R.; Gale, W.W.; McElhannon, W.A. Jr.; Davenport, O.W.; Petrichuk, M.D.; Ashcraft, T.L. *Society of Petroleum Engineers of A.I.M.E. (American Institute of Mining, Metallurgical and Petroleum Engineers), Paper;* 933-952(1982). (CONF-820419—).

A successful surfactant (microemulsion) flood pilot est has been completed by Exxon in a watered-out portion of the Weiler sand, Loudon Field, Fayette County, Illinois. The microemulsion system tested was designed to be effective in the presence of high-salinity formation water containing 104,000 ppM (mg/l) total dissolved solids (TDS) without use of a preflush. The test was conducted in a single, 0.68-acre 5-spot operated to approximate a confined pattern. Approximately 60 percent of the waterflood residual oil present in the pilot pattern was recovered. Extensive data for determining sweep and displacement efficiencies were obtained from observation well logs and fluid tracers. Although problems were encountered with bacterial degradation of biopolymer and with produced oil-water emulsions, the test is considered to be a technical success and confirms the effectiveness of the high-salinity microemulsion formulation. Additional pilot tests are needed to determine the effects on oil recovery of microemulsion bank size and well spacing.

29047 **Measuring well injection profiles of polymer-containing fluids.** Bragg, J.R.; Roesner, R.E.; Strassner, J.E. *Society of Petroleum Engineers of A.I.M.E. (American Institute of Mining, Metallurgical and Petroleum Engineers), Paper;* 953-962(1982). (CONF-820419—).

An experimental study of the performance of a radioactive tracer flow log has been conducted in Loudon pilot wellbores and in a visual flow loop. The major results of this study are are follows. (1) When a viscous polymer solution is being injected into a wellbore, injection flow profiles as measured by a conventional tracer log are likely to be erroneous and completely misleading. (2) Because polymer solutions are usually injected at rates wherein laminar flow exists in the wellbore, tracer must be ejected at a velocity that is just sufficient to place the tracer in substantially the center of teh annular region between the tool and the wellbore. Tracer ejected at too high a velocity will travel to the casing or wellbore wall and subsequently move at a rate that is significantly less than the true average annular velocity. Tracer ejected too close to the log tool will incur the same problems. (3) The tracer ejector of a conventional tool can be modified to reduce the velocity of the injected tracer by increasing the number of ports, the diameter of the ports, or both, as needed to place the tracer near the center of the annular region. (4) Reasonably accurate flow profiles have been measured for injected fiscous microemulsion and polymer drive water using a modified tracer flow log. (JMT)

29048 **Mobile wellhead analyzer for the determination of unstable constituents in oil-field waters.** Hoke, S.H.; Collins, A.G. (US Army, Fort Detrick, Frederick, MA, USA). *American Society for Testing and Materials, Special Technical Publication;* 34-38(1981). (CONF-800192—).

From 2. symposium on water for subsurf injection (ASTM); Ft. Lauderdale, FL, USA (28 Jan 1980).

A brine analyzer was designed that measures hydrogen ion concentration, redox potential (Eh), oxygen, conductivity, sulfide ion (S^{--}), HCO^{-3}, and carbon dioxide in oil-field water at the wellhead. When oil-field brine samples are collected in the field and transported to the laboratory for analysis, many of the unstable constituents change in concentration. The amounts of the constituents in the original sample. Thus, an analysis of the brine at the wellhead is necessary to obtain reliable data. 10 refs.

0204 Processing

29049 **(DOE/MC/14875—1373) Solids backmixing in high-velocity beds.** Avidan, A.; Weinstein, H.; Graff, R.A. (City Coll., New York (USA). Clean Fuels Inst.). May 1981. Contract AC21-80MC14875. 221p. NTIS, PC A10/MF A01. Order Number DE83008411.

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High-velocity gas fluidization includes the turbulent- and fast-fluidization regimes which lie beyond the low-velocity bubbling or slugging regimes. Bed expansion and solid mixing were studied in 15.2-cm ID rigs, of high aspect ratios. Fine cracking catalysts of Geldart's group A classification were used and air used at 0.075 to 6.5 m/s, solid rate in the upper end of the fast fluidization regime topped 150 kg/m^2s. The Two-Phase Theory does not apply when the gas velocity is raised beyond the slugging regime: the bed structure becomes more homogeneous. Particulate-like fluidization describes these high-velocity regimes. A modified Richardson-Zaki approach is used to correlate bed expansion. It is shown to confirm the more homogeneous nature of the turbulent and fast regimes, and the validity of the concept of clusters - or the tendency of fine particles to aggregate. Solid mixing was studied with a ferromagnetic tracer and modelled by a turbulent eddy-diffusivity dispersion model. Implications for heat transfer in a high-velocity fluidized bed are discussed.

0206 Health And Safety

REFER ALSO TO CITATION(S) 29082, 29089, 30548

0207 Marketing And Economics

29050 **(DOE/EIA—0032(82/13)) Monthly petroleum product price report.** (USDOE Energy Information Administration, Washington, DC). Dec 1982. 18p. NTIS, PC A02/MF A01. Order Number DE83009769.

This report provides information on monthly national weighted average prices for refined petroleum products. Data are presented on motor gasoline, diesel fuels, residual fuel oils, aviation fuels, kerosene, petrochemical feedstocks, and liquefied petroleum gases for 1981 and 1982. (DMC)

0208 Waste Management

REFER ALSO TO CITATION(S) 30379

0209 Environmental Aspects

REFER ALSO TO CITATION(S) 30398, 30533, 30534

29051 **(PB—83-149104) Assessing the impact of oil spills on a commercial fishery. Final report.** (Rhode Island Univ., Kingston (USA). Dept. of Ocean Engineering). 1 Nov 1982. 248p. NTIS, PC A11/MF A01.

An oil spill fishery impact assessment system composed of fishery, hydrodynamic, ichthyoplankton transport and fates submodels has been applied to assess the probable impact of oil spills on several key fisheries in the Georges Bank - Gulf of Maine region. The model system addresses direct impacts of oil on the commercial fishery through hydrocarbon induced egg and larval mortality.

29052 **Principal offshore oil-spill accidents and tanker casualties databank (1955-1980) compiled by the Institut Francais du Petrole.** Bertrand, A. (Institut Francais du Petrole, Rueil-Malmaison, France). *CODATA Bulletin;* No. 39, 15-19(Dec 1980). (CONF-8003188—).

From French/Israeli interdisciplinary symposium on problems in the treatment of numerical data; Jerusalem, Israel (5 Mar 1983).

The IFP Databank on accidental offshore oil pollution by ships is described. This databank contains information on: the acci-

dent, the ship, the cargo, chronology of the pollution, pollution-control measures, impact, and miscellaneous comments. Information is obtained from Lloyds, Tanker Casualty Library, Center for Short Lived Phenomena, and the general literature. Examples of data are presented. (DMC)

0210 Legislation And Regulation

REFER ALSO TO CITATION(S) 28984

29053 **(GAO/RCED—83-33) Status of the Administration's implementation of the Energy Emergency Preparedness Act of 1982.** (General Accounting Office, Washington, DC (USA). Resources, Community and Economic Development Div.). 8 Oct 1982. 10p. General Accounting Office, P.O. Box 6015, Gaithersburg, MD 20760.

A status report is given on DOE's implementation of the Energy Emergency Preparedness Act of 1982. It considers statutory report requirements and deadlines as well as interagency coordination in developing and approving these reports. Tentative conclusions are that the dates will be met but reports will be general in nature. (PSB)

0220 Transport, Pipelines, And Handling

29054 **(LCC—001/80) Study of pipe-whip parameters in pipelines.** Guerreiro, J.N.C.; Loula, A.F.D.; Galeao, A.C.N.R. (Laboratorio de Computacao Cientifica, Rio de Janeiro (Brazil)). 1980. 12p. (In Portuguese). NTIS (US Sales Only), PC A02/MF A01. Order Number DE83701513.

The problem of the high energy pipe-whip, assuming an elastic-plastic behavior for the tube material and taking in account the internal pressure, is studied. The constraints are simulated as bilinear springs and viscous dampers. A general research, based on the finite element method was developed to analyse the phenomenon. The influence of the following parameters: gap, damping coefficient, stiffness, constraints positioning and internal pressure of the tube is studied.

0230 Properties

29055 **Characterization of Cerro Negro crude. Part I. Physical and chemical separations.** Grizzle, P.L. (Bartlesville Energy Technology Center, OK); Green, J.B.; Sanchez, V.; Murgia, E.; Lubkowitz, J. *American Chemical Society, Division of Petroleum Chemistry, Preprints;* **26**: No. 4, 839-850(Sep 1981). (CONF-810813—(Vol.2)).

From National American Chemical Society summer meeting; New York, NY, USA (23 Aug 1981).

The scheme couples distillation and ion exchange and solid liquid chromatography in an attempt to prepare narrow-boiling, chemically unique fractions, which can be analyzed further or can supply data for process development. For evaluation of the separation approach, a Cerro Negro crude from the Venezuelan Orinoco basin has been studied in a cooperative program between the United States Department of Energy and the Institute de Tecnologico del Venezolana Petroleo. These fractions may be analyzed by ir, uv, fluorescence, and nuclear magnetic resonance spectroscopy, as well as various mass spectroscopy methods. The approach appears to be promising. 5 figures, 6 tables.

29056 **Characterization of Cerro Negro crude. Part II. Chemical analysis.** Sturm, G.P. Jr. (Bartlesville Energy Technology Center, OK); Grindstaff, Q.G.; Hirsch, D.E.; Scheppele, S.E.; Hazos, M. *American Chemical Society, Division of Petroleum Chemistry, Preprints;* **26**: No. 4, 851-856(Sep 1981). (CONF-810813—(Vol.2)).

From National American Chemical Society summer meeting; New York, NY, USA (23 Aug 1981).

The cooperative research program is explained in Part I. An evaluation is presented of the resolution attained in the separation of a 425 to 550°C petroleum distillate fraction according to compound classes using 2 chromatographic methods. Samples were separated by high performance liquid chromatography using 2 columns in series containing 2,4-dinitroanalinopropyl silica and silica, respectively. Initial elution was attained using 1% methylene chloride in pentane followed by a linear gradient up to 30% methylene chloride. In the 2nd method, developed in the American Petroleum Institute's Research Project 60, fractions designated as saturates, monoaromatics, diaromatics, and polyaromatics were collected froma dual silica/alumina column using step gradient elution with pentane, 5% benzene in pentane, 15% benzene in pentane, and 20% ethyl ether, 20% benzene, 60% methanol, followed by pure methanol. The results wil be used to evaluate the quality of the separation in terms of the success in producing fractions containing similar compound classes. 1 figure, 4 tables.

0240 Storage

29057 **(SAND—82-2189) User instructions for programs NEDIT and NPRED.** Gross, R.J. (Sandia National Labs., Albuquerque, NM (USA)). Feb 1983. Contract AC04-76DP00789. 47p. NTIS, PC A03/MF A01. Order Number DE83010975.

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NEDIT and NPRED are computer programs developed for the Strategic Petroleum Reserve (SPR) Program to assist the SPR system designers and operators in scheduling the leaching and oil-filling of the SPR salt caverns. NEDIT is an interactive program which assists the user in creating or editing a data set; NPRED in turn uses this data set to perform the engineering calculations. Various activities are necessary to achieve a man-made cavern filled with a maximum quantity of oil in minimum time. NPRED predicts the time required for each such activity, thus providing a site oil-capacity schedule. Instructions for using the codes are presented and examples are shown. 1 figure, 5 tables.

0250 Combustion

REFER ALSO TO CITATION(S) 28977, 30095

03 NATURAL GAS

0302 Geology And Exploration

REFER ALSO TO CITATION(S) 28879, 30587, 30594

29058 **(DOE/ET/12138—1272) Study of hydrogeologic trends in exploration for Devonian-shale gas in the Midway-Extra gas field of Putnam County, West virginia.** Beebe, R.R. (West Virginia Univ., Morgantown (USA). Dept. of Geology and Geography). Sep 1979. Contract AC21-76ET12138. 153p. NTIS, PC A08/MF A01. Order Number DE83008487.

A hydrogeologic study was conducted in the Midway-Extra gas field where gas wells tap Devonian shales in northern Putman County, West Virginia. Lineaments were mapped and shallow ground water was surveyed for physical and chemical parameters, to determine if lineaments or ground water may be useful for shale gas exploration. Landsat lineaments, defined from satellite imagery, have no apparent effect on water well yield and are associated with low gas well yields. Short photolineaments, defined from low-altitude stereo photography, are excellent sites for high-yielding water wells and good sites for high-yielding gas wells in general. These lineaments appear to represent permeable zones about 400 feet wide at shallow depth. The density of photolineaments orientated N60°W-N30°E is especially well associated with high-yielding gas well trends. Final open flow is especially great for gas wells near water wells or springs having high bicarbonate or nitrate concentrations. High bicarbonate content is in part likely to be caused by oxidation of methane gas in shallow ground water. Photolineaments and ground water chemistry may well prove to be valuable exploration tools for Devonian shale gas in other areas. 20 figures, 21 tables.

29059 **(DOE/ET/12138—1343) Method to identify zones of intense jointing with application to the Parsons Lineament, West Virginia.** Dixon, J.M. (West Virginia Univ., Morgantown (USA). Dept. of Geology and Geography). Apr 1979. Contract AC21-76ET12138. 49p. NTIS, PC A03/MF A01. Order Number DE83007805.

Studies of water well yields, of three roadcuts, and of field observations indicate that the Parsons lineament in eastern West Virginia is a broad, cross-strike zone of unusually intense jointing. To test this hypothesis, strike, dip, exposed length, exposed depth, and spacing of 1594 joints were measured in interbedded siltstones, mudstones, and shales in the Upper Devonian Chemung facies. Joint sets were determined to strike N 35 to 55° W, N 25 to 45° E, and N 80° E - N 80° W. SYMAPS show more intense jointing within the Parsons lineament with the northeast-trending set contributing most to the increase. Identification of zones of intense jointing could be useful in hydrocarbon exploration, mine design, construction, and water-well siting. 8 figures, 1 table.

29060 **(DOE/MC/08216—1276) Distribution of gas, organic carbon, and vitrinite reflectance in the eastern Devonian gas shales and their relationship to the geologic framework.** Streib, D.L. (Science Applications, Inc., Morgantown, WV (USA)). Feb 1981. Contract AM21-78MC08216. 273p. NTIS, PC A12/MF A01. Order Number DE83007234.

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Gas volume data from outgassing tests were available from twenty one sites in the Appalachian Basin and seven sites in the Illinois Basin. Most of these sites also had data available on organic carbon and vitrinite reflectance. Gas volume distribution varies with each stratigraphic unit tested in the Appalachian Basin. Thermal maturity increased from northwest to southeast in the Appalachian Basin. Gas volume, organic carbon, and thermal maturity increased from northwest to southeast in the Illinois Basin. High gas volumes were present in the Appalachian Basin in the Cleveland, Upper Huron, and Lower Huron Members of the Ohio Shale, the Rhinestreet Member of the West Falls formation, and the Middlesex Member of the Sonyea formation. In the Illinois Basin, The Grassy Creek and Sweetland Creek Shales of the New Albany showed relatively high gas volumes at some locations. Prior production areas of the Appalachian Basin are characterized by a thick sequence of radioactive shale, high measured gas volume, optimum stress ratio, and optimum thermal maturity. These same characteristics are present in an extensive area of Ohio, Pennsylvania, and New York and present areas of optimum exploration potential. The Devonian shale gas resource of the Illinois Basin is most probably the area of southeastern Illinois and adjacent areas of Indiana and Kentucky.

29061 **(DOE/MC/08216—1380) Reservoir engineering aspects and resource-assessment methodology of eastern Devonian Gas shales.** Kucuk, F.; Alam, J.; Streib, D.L. (Science Applications, Inc., Morgantown, WV (USA)). Oct 1978. Contract AM21-78MC08216. 52p. NTIS, PC A04/MF A01. Order Number DE83008462.

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The US Department of Energy's Morgantown Energy Technology Center (METC) and Science Applications, Inc., are cooperating in the characterization of the eastern Devonian Shale gas resource. This study, focusing on the Lincoln County, WV, area, characterizes the resource and shows that conventional volumetric techniques cannot be used to determine the amount of gas in place. Previous studies, using calculations based on limited offgassing measurements and volumetric information, have indicated that the resource ranges from 500 TCF to 2400 TCF of gas in place. The volumetric method based on fracture porosity data yields low values; offgassing measurements can be used to determine gas in place if sufficient time is allowed for gas to sorb from the shale matrix. Production-pressure decline curves are presented for several wells to show the effect of sorption of cumulative production. A mathematical model for describing the behavior of a dual-porosity gas reservoir is presented. It shows the effect of sorption on the production behavior of the gas reservoir. It is concluded that the early part of production behavior is controlled by free gas in the fractures, while long-time behavior is controlled by sorption-diffusion mechanisms. 16 figures, 5 tables.

29062 **(DOE/MC/14394—1365) Shallow seismic investigations of Devonian-shale gas production.** Williams, R.T.; Ruotsala, J.E.; Kudla, J.J.; Dunne, W.E. (West Virginia Univ., Morgantown (USA). Dept. of Geology and Geography). Jun 1982. Contract AT21-80MC14394. 218p. NTIS, PC A10/MF A01. Order Number DE83008964.

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The foremost conclusion of this study is that fractured Devonian shale gas reservoirs, as exemplified by the Cottageville field, are detectable by seismic reflection methods. Further, the target is not particularly difficult, once the nature of the seismic anomaly is understood. The preferred exploration rationale is based on travel time anomalies related to lowered acoustic velocity within the gas-bearing zone. In the simplest case the travel time anomaly causes an apparent down-warp or sag in a flat-lying reflector. This conclusion is developed in Parts B and C of this report. Concerning the high-resolution extension of the seismic method, which is the subject of Part A, there are essentially two separate conclusions which can be drawn. One is that additional, valuable subsurface information can be obtained by recording seismic data at frequenies higher than those in common use by the petroleum industry at the time of this writing. The other is that it is feasible to obtain seismic reflection data on a smaller scale, using less costly instrumentation, than is typically employed in the petroleum industry. However, it is not yet possible to say whether such small scale surveying will be practical from an industry point of view.

0303 Drilling, Production, And Processing

REFER ALSO TO CITATION(S) 29061

29063 **(DOE/MC/19146—1400) Drilling of a deviated well: E.C. Newell 10056-D Meigs County, Ohio.** Rodgers, J.A. (Gruy Petroleum Technology, Inc., Houston, TX (USA)). 30 Sep 1982. Contract AC21-82MC19146. 86p. NTIS, PC A05/MF A01. Order Number DE83008761.

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The Department of Energy's (DOE) Eastern Gas Shales Program (EGSP) has focused primarily on the resource characterization of the Devonian shales in the Appalachian, Michigan and Illinois Basins, where the collective volume of gas in place is estimated to be on the order of 280 Tcf. From an early assessment of the petrophysical properties of these shales, attention now has turned to an understanding of the mechanisms controlling production of this unconventional-gas source. However, present knowledge of the production history of the Devonian shales is inadequate for an accurate estimation of the gas reserves, the optimum well spacing for gas extraction, and the preferred stimulation techniques to be used. As part of this program, a Deviated Well Test was designed to evaluate the spacing of natural fractures in the Devonian shale in Meigs County, Ohio as a follow-on test to further define shale production characteristics and to assess the benefit of additional section gained by drilling through the producing interval at the approximate angle for dip of 60° from vertical. The Columbia Gas Transmission Company, E.C. Newell 10056-D well, on the same site as a previous Off-Set Well Test, was selected for this investigation. This report summarizes drilling operations on this Deviated Well Test.

0308 Environmental Effects

REFER ALSO TO CITATION(S) 30398

0320 Transport, Pipelines, And Handling

29064 **(NP-tr—3901801) Inspection requirements for flexible gas-meter connections.** (British Gas Corp., Newcastle-upon-Tyne). 1970. Translation source information not available . 23p. NTIS (US Sales Only), PC A02/MF A01. Order Number DE83901801.

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A flexible gas meter connection comprises a junction consisting of a corrugated metal pipe with coupling elements between the service pipe above ground or the gas pressure regulator and the gas meter and/or between the gas meter and the internal pipe, or the gas-failure safety device. These inspection requirements apply to flexible gas meter connections with a nominal internal diameter of 20 to 50 mm inclusive, suitable for natural gas with a gas pressure of a maximum of 200 mbars.

29065 **(NP-tr—3901802) Provisional amendment No. 2 to the inspection requirements for flexible gas meter connections.** (British Gas Corp., London). [nd]. C;353/81/K and N/200, Aug. 1981; Veg-Gasinstituut n.v., Apeldoorn, Netherlands. 9p. NTIS (US Sales Only), PC A02/MF A01. Order Number DE83901802.

The amendment pertains to the requirements for gas meter coupling, tap coupling, thread, flanges, connections between the coupling element/corrugated pipe, and torsional stress. (DLC)

04 OIL SHALES AND TAR SANDS

0401 Reserves And Exploration

REFER ALSO TO CITATION(S) 29058, 29061, 29062

0402 Site Geology And Hydrology

REFER ALSO TO CITATION(S) 29060

0403 Drilling, Fracturing, And Mining

REFER ALSO TO CITATION(S) 29063

29066 **(SAND—82-2965C) Engineering model for prediction of in-situ oil-shale retort blasting.** Schamaun, J.T. (Sandia National Labs., Albuquerque, NM (USA)). 1983. Contract AC04-76DP00789. 15p. (CONF-830434—1). NTIS, PC A02/MF A01. Order Number DE83009931.

From 16. oil shale symposium; Golden, CO, USA (13 Apr 1983).

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The in-situ extraction of oil from most oil shale beds is highly dependent upon explosive fracturing and rubbing of rock in a controlled and predictable manner. In blasting, it is necessary not only to fracture the rock, but also to move the broken rubble in a predictable manner. Most in-situ extraction techniques require rubblization to take place in a confined region where rock motion is a predominate factor in creating a permeable broken bed. In this paper, an engineering model is presented which describes the large rubble motion during blasting. This model is intended to provide the blast designer with a tool for evaluation and further refinement of blasting patterns and timing sequences. In this model the rock medium is represented by a discrete series of circular regions of fractured material. These regions are set in motion by pressure loads from the explosive. The motion of the regions is calculated using a step-wise, explicit, numerical time integration method. Interaction of adjacent regions is based on inelastic impact of spherical bodies. The derivation of this model is presented along with the background for selecting loading pressure based on explosive behavior. Three typical examples are discussed which illustrate the use of this model to predict rubble motion. This engineering representation appears to provide a practical model for use in predicting rubble motion and a tool for design evaluation of blasting in confined geometries. 16 figures, 1 table.

0404 Oil Production, Recovery, And Refining

REFER ALSO TO CITATION(S) 29066

29067 **(DOE/LC/10787—109) Investigation of the geokinetics horizontal in-situ oil-shale retorting process. Sixth annual report, 1982.** Wege, L. (ed.). (Geokinetics, Inc., Salt Lake City, UT (USA)). Apr 1983. Contract FC20-78LC10787. 153p. NTIS, PC A08/MF A01. Order Number DE83010197.

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The Geokinetics in situ shale oil project is a cooperative venture between Geokinetics and the US Department of Energy. The objective is to develop a true in situ process for recovering shale oil using a fire front moving in a horizontal direction. The project is being conducted at a field site, Kamp Kerogen, located 70 miles south of Vernal, Utah. This 6th Annual Report covers work completed during the calendar year 1982. During 1982, two 2 acre retorts were blasted and two 1 acre retorts were burned. A total of 33,232 barrels of crude shale oil were produced. 65 figures, 22 tables.

29068 **(LA—9640-SR, pp 28-31) Laboratory-scale retort.** Gonzales, M.; Tillery, M.; Holland, L.M.; Vigil, E.; Royer, G. Feb 1983. NTIS, PC A06/MF A01.

In Los Alamos integrated oil shale health and environmental program. Status report II.

A laboratory-scale retort designed and built at the Laramie Energy Technology Center for use in the oil shale toxicology studies is described in this report. The original retort was modified into two shorter retorts (each 150 cm long). A schematic view of one retort is included. The retort is constructed from stainless steel pipe with an outside diameter of 8.9 cm and an inside diameter of 7.6 cm. Eight independently controlled electrical resistance heaters surround the retort. Each heater is 15 cm tall and is covered with an insulator. Temperatures in the retort are monitored by means of a thermocouple well consisting of a stainless steel pipe 1.6 cm in diameter, located in the center of the retort. In addition to centerline temperature, gas temperature is monitored in the liquid trap, inlet gas flow rate is monitored, and the exhaust gases are continuously analyzed for carbon monoxide (CO) and hydrogen sulfide (H_2S). Periodic grab samples are collected to determine the concentration of specific compounds and total organic carbon (TOC).

29069 **(SAND—83-0828C) Controlled-source audio magnetotelluric (CSAMT) survey of steamflood in subsurface tar sands.** Wayland, J.R. Jr.; Lee, D.O.; Montoya, P.C. (Sandia National Labs., Albuquerque, NM (USA)). 1983. Contract AC04-76DP00789. 20p. (CONF-830533—1). NTIS, PC A02/MF A01. Order Number DE83009937.

From Symposium on synthetic fuels from oil shale and tar sands; Louisville, KY, USA (17 May 1983).

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A steamflood experiment, designated TS-1S, was conducted by US DOE Laramie Energy Technology Center in the Northwest Asphalt Ridge Tar Sand. The later stages of this experiment were mapped at depth using the controlled-source audio magnetotelluric (CSAMT) technique to assist in determining the location of the steam front. Normalized maps were produced which are consistent with the production data, temperature data from monitoring wells, and post-test coring data. The results indicate that the CSAMT technique shows promise for monitoring thermal-front locations. 9 figures, 2 tables.

29070 **Characterization of in-situ oil-shale retorts prior to ignition.** Turner, T.F.; Moore, D.F. US Patent Application 6-385,206. 4 Jun 1982. 23p.

Method and system for characterizing a vertical modified in situ oil shale retort prior to ignition of the report. The retort is formed by mining a void at the bottom of a proposed retort in an oil shale deposit. The deposit is then sequentially blasted into the void to form a plurality of layers of rubble. A plurality of units each including a tracer gas cannister are installed at the upper level of each rubble layer prior to blasting to form the next layer. Each of the units includes a receiver that is responsive to a coded electromagnetic (EM) signal to release gas from the associated cannister into the rubble. Coded EM signals are transmitted to the receiv-

ers to selectively release gas from the cannisters. The released gas flows through the retort to an outlet line connected to the floor of the retort. The time of arrival of the gas at a detector unit in the outlet line relative to the time of release of gas from the cannisters is monitored. This information enables the retort to be characterized prior to ignition. 9 figures.

29071 **Street ranch pilot test of fracture-assisted steamflood technology.** Britton, M.W.; Martin, W.L.; Leibrecht, R.J.; Harmon, R.A. *Society of Petroleum Engineers of A.I.M.E. (American Institute of Mining, Metallurgical and Petroleum Engineers), Paper;* 455-480(1982). (CONF-820419—).

A new in situ steamflood method called the FAST process, for Fracture Assisted Steamflood Technology, has been developed and tested in a South Texas tar sand deposit. Preliminary results indicate that the FAST process should be applicable in other tar sand deposits and heavy oil reservoirs. The first test of the FAST process in a tar sand deposit was performed in a 5 acre (2 ha) inverted 5 spot pilot pattern located on Conoco's Street Ranch lease in Maverick County, Texas. The target formation was the 50 foot (15.2 m) thick San Miguel-4 tar sand located at a depth of 1500 feet (456 m). During the 31 month period ending June 1980, the Street Ranch pilot produced 169,040 barrels (26,875 m^3) of -2°API (1093 kg/m^3) tar. The steam to tar ratio (SOR) was 10.9 barrels/barrel (m^3/m^3) and the thermal ratio (TR) was 1.64 Btu/Btu (J/J). Horizontal fractures and high steam injection rates were effective in mobilizing the extremely viscous hydrocarbon, and pressures at the center injector caused all wells to flow. Monthly average tar production rates occasionally exceeded 300 BPD (48 m^3/d). An eight well, post pilot coring program confirmed localized residual tar saturations averaging 8 percent near the injection well and an average recovery efficiency of better than 50 percent. Details relating to: (1) the nature of the tar resource, (2) the development of the FAST process, and (3) the design, operation, results, and conclusions of the Street Ranch pilot are discussed in this paper.

0405 Properties And Composition

29072 **(DOE/LC/RI—83-5) Triaxial testing of oil shale from the Devonian Chattanooga shale formation in Dekalb County, Tennessee.** Chong, K.P.; Chen, J.L.; Dana, G.F.; Sailor, S. (Wyoming Univ., Laramie (USA). Dept. of Civil Engineering). Apr 1983. Contract AS20-82LC10877. 20p. NTIS, PC A02/MF A01. Order Number DE83009333.

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Triaxial tests with confining pressures of up to 14 MPa (2000 psi) to simulate the overburden pressure, etc., are performed on duplicate sets of cores taken from Silver Point Quad in DeKalb County, Tennessee. Oil yields in the specimens ranged from 35 l/t (8.4 gal/ton) to 65 l/t (15.6 gal/ton). A Mohr-Coulomb failure model was developed making use of p-q plots and statistical analysis. A significant finding of this study is that the failure of Tennessee oil shale under confining pressures is independent of the richness of the oil shale. Cohesion and angle of internal friction of oil shale are obtained with high accuracy. 7 figures, 1 table.

29073 (LA—9640-SR, pp 85-91) **Analytical chemistry of oil shale.** Spall, W.D. Feb 1983. NTIS, PC A06/MF A01.

In Los Alamos integrated oil shale health and environmental program. Status report II.

The status of this program is discussed under the headings: solvent extraction studies of shale oil materials, evaluation of air and dust samples from oil shale, and fractionation and analysis of oil shale retort water. Procedures for the analysis of extracts of crude oils and solids have been developed in order to determine the compounds responsible for observed biological activity of the material. The variability of the chemical composition of extracts can present problems in the use of biological tests to assess the potential biological hazard of crude oils, fractional oils, and extracts from energy-related materials. Two different types of air samples were investigated - vapor phase organic materials collected with various sampling tubes and respirable-sized dust particles generated in the inhalation facility (Group H-5). The vapor phase organic samples were collected from four oil shale pilot facilities. Nearly 400 compounds were identified in the samples, and some 50 target compounds have been identified as monitor compounds. A more detailed investigation of retort water obtained from the Paraho process has been undertaken. Previous studies of the water showed it to possess the greatest mutagenic activity in the Ames test and the greatest organic content of any of the waters tested. In an attempt to determine the chemical species responsible for the observed mutagenic activity, the water was fractionated and each fraction was tested and fractionated further as required.

29074 **(UCID—19751) Organic and pyritic sulfur determination in oil shale.** Fadeff, S.K.; Burnham, A.K.; Richardson, J.H. (Lawrence Livermore National Lab., CA (USA)). 1 Mar 1983. Contract W-7405-ENG-48. 27p. NTIS, PC A03/MF A01. Order Number DE83009703.

Sulfur forms in oil shale are defined according to their reduction rates to H_2S in the presence of hydrogen-donor solvents. A linear increase in temperature with time is applied to a reaction system of oil shale and hydrogen-donor solvents. The different temperatures at which H_2S is detected corresponds to specific sulfur-functionality reductions and produces a reaction profile, or kinetogram. The kinetograms of 10 standards and 13 different oil shales are given. The method of analysis is simple. Aromatic and aliphatic disulfides, sulfides, thiols, and pyrite can be detected, however we are not yet sure about the detection of thianthrene structures and thiophenic structures. Our present results indicate that this is a promising approach, but improvements in the procedure must be made to optimize the analytical technique.

29075 **Static and dynamic fracture behavior of oil shale.** Costin, L.S. (Sandia Natl Lab, Albuquerque, NM, USA). *American Society for Testing and Materials, Special Technical Publication;* 169-184(1981). (CONF-8006254—).

From ASTM conference on fracture mechanics for ceramics, rocks and concrete; Chicago, IL, USA (23 Jun 1980).

The fracture toughness of a rich grade of oil shale (high kerogen content) was determined as a function of the loading rate and orientation of the crack with respect to the bedding planes. Several independent test methods were employed in order to attain a wide range of loading rates and to examine the effect of specimen size and configuration on the test resluts. The test methods used in this series of experiments include ASTM Test for Plane-Strain Fracture Toughness of Metallic Materials (E 399 - 78a), the J-resistance curve method, the short rod method, and the instrumented Charpy impact test. The static tests were conducted at a nominal loading rate of 10^{-3} MPa. m/sup //one-half/sub s/ using each of the aforementioned first three methods. The dynamic tests were conducted at loading rates in the range of 10/degree/to 10^{4} MPa . m/sup // one-half/sub s/ using both servo-controlled and impact loading of three-point bend specimens. The results from the various static test methods are in good agreement. However, there is a clear effect of both specimen size and crack orientation on the measured static fracture toughness. The results from the dynamic tests show some evidence of a rate effect on fracture toughness as well as the same orientation dependence as the results from the static test, but no specimen size dependence was evident. 16 refs.

0407 Health And Safety

REFER ALSO TO CITATION(S) 28982, 29093, 30547

29076 (LA—9640-SR, pp 4-13) **Oil shale workers health study.** Hargis, K.M.; Ettinger, H.J.; Tillery, M.I.; Gonzales, M.; Jackson, J.O.; Golias, E. Feb 1983. NTIS, PC A06/MF A01.

In Los Alamos integrated oil shale health and environmental program. Status report II.

The Oil Shale Workers Health Study includes components of both industrial hygiene and occupational medicine. Industrial hygiene activities involve field studies to determine if unique health hazards are associated with alternate oil shale technologies, to assist in the design of toxicological studies, and to provide bulk material for use in these studies. Emphasis has been placed on the retorting unit operation because this phase appears most likely to produce unique hazards. Industrial hygiene studies have also been performed at Occidental and Rio Blanco facilities during the burn of under-

ground MIS retorts. During FY81, industrial hygiene field studies were conducted at the Geokinetics TIS oil shale facility and sampling was performed at the Rio Blanco MIS facility during the burn of a second and larger retort. Medical evaluations were carried out on employees at the Geokinetics TIS site. A proposal was developed for a comprehensive study during the simultaneous burn of two commercial-size MIS retorts at the Occidental Logan Wash facility during FY82. Continuing support was provided to the DOE Health and Environmental Oil Shale Task Force.

29077 (LA—9640-SR, pp 13-16) **Medical studies of oil shale workers at Geokinetics, Inc., Vernal, Utah.** Voelz, G.L.; Grier, R.S. Feb 1983. NTIS, PC A06/MF A01.

In Los Alamos integrated oil shale health and environmental program. Status report II.

The purpose of this study was to evaluate the health of oil shale workers at a true in situ retort and to gather baseline data for future prospective study. The health of the workers and their wives was generally good. The variety of relatively minor skin problems noted in 11 subjects cannot be clearly associated with in situ shale oil retorting, as there seem to be a greater number of extraneous environmental factors (such as arid climate, intense solar exposure, surface dust, perspiration, and hygienic shortcomings) which probably play a greater role than the retorting and shale oil recovery process. Also, the average length of exposure is relatively short for any direct relationship to shale oil to be established. Respiratory function of the workers is excellent at the present time with the average length of employment only 19 months. Further surveillance may be desirable considering the possibility of exposure to respiratory toxicants. It should be noted that the cooperation and helpfulness of the staff and workers of Geokinetics, Inc., was outstanding.

29078 (LA—9640-SR, pp 16-19) **Sister chromatid exchange rates in Geokinetics oil shale workers.** Campbell, E.W.; Ray, F.A.; Deaven, L.L. Feb 1983. NTIS, PC A06/MF A01.

In Los Alamos integrated oil shale health and environmental program. Status report II.

Studies were performed to determine the rate of sister chromatid exchanges (SCE) in lymphocytes from workers and adult family members associated with the Geokinetics in-situ retorting site in Uinta County, Utah. Results are presented for 22 male workers and 7 female family members. Future sampling of these workers and their families will provide an opportunity to find out if the SCE rates change as a result of working and living in this unique environment. The results presented here will serve as base-line rates of SCE frequency for each individual. (DMC)

29079 (LA—9640-SR, pp 24-27) **Aerosol support.** Gonzales, M.; Tillery, M.; Royer, G.; Vigil, E. Feb 1983. NTIS, PC A06/MF A01.

In Los Alamos integrated oil shale health and environmental program. Status report II.

Inhalation toxicology studies are reported on small-animal inhalation exposure to representative oil shale airborne materials. Such exposures are being caried out in the nose-only mode on a six-hour day, four days per week schedule. Current or recently suspended studies include seven groups initially composed of 62 animals each. All animals in a group are exposed simultaneously in one chamber. The exposure aerosols are tabulated. The six oil shale inhalation exposure groups involve (1) Paraho spent shale, longevity study; (2) Paraho raw shale, longevity study; (3) Paraho raw shale, serial sacrifice study; (4) Paraho raw shale, low-level longevity study; (5) Paraho raw shale, intermediate-level longevity study; and (6) Estonian raw shale, longevity study. The Estonian raw shale was obtained by a mutual study agreement with Russia. In addition, a positive-control group has been exposed to a pure α-quartz aerosol dispersed by nebulizer from a water suspension. Method for preparing the aerosol is included.

29080 (LA—9640-SR, pp 31-35) **Inhalation studies.** Holland, L.M.; Wilson, J.S.; Tillery, M.I.; Gonzales, M.; Vigil, E.A.; Royer, G.; Stavert, D.; Archuleta, D. Feb 1983. NTIS, PC A06/MF A01.

In Los Alamos integrated oil shale health and environmental program. Status report II.

A study to determine the long-term effects of inhaling high concentrations of shale dusts is in progress. Female Fischer-344 rats were exposed to high concentrations of either Anvil Points raw shale, Paraho spent shale, or quartz. Histopathological examination of tissues was performed. In addition to the anticipated fibrotic changes, lungs from several animals in each group contained primary tumors. Only one benign tumor has been observed in the untreated controls. The earliest tumors were observed after 17 months of exposure, indicating the lateness of the tumorigenic phenomenon. Histopathological analysis of all tissues from all animals is incomplete, and the number of animals examined in each group varies. Because of this, the comparative incidence of lung tumor among the exposure groups cannot yet be established. The tumor type most frequently observed in all groups was adenocarcinoma with adenoma the next most frequent. Three squamous cell carcinomas have been observed so far with no apparent relationship to exposure group. Results indicate that high exposures have led to a lung-scar cancer phenomenon in the lungs because of the high incidence in lung tumors in the quartz-exposed group. Therefore, the lung tumors observed in these experiments may be a sequel to advanced pulmonary fibrosis rather than the result of exposure to specific carcinogens. (DMC)

29081 (LA—9640-SR, pp 36-40) **Biochemical and cellular effects of inhalation exposure to oil shale dusts.** Halleck, M.S.; Saunders, G.C.; Wilson, J.S.; Tate, E.H.; Stewart, C.C.; Martinez, E. Feb 1983. NTIS, PC A06/MF A01.

In Los Alamos integrated oil shale health and environmental program. Status report II.

Inhalation studies comparing the effects of high-level exposure to Paraho raw and spent shale dusts are presently being completed. Groups of 64 Fischer-344 rats were given nose-only exposure 6 h per day, 4 days per week for 24 months to either Paraho raw or spent shale dust at a concentration of 150 mg/m^3. Pulmonary lavage was performed. Lavage contents were analyzed for total cell yield, differential cell types, clonogenicity of pulmonary macrophages and elastolytic activity. Lung wet weights were measured for the unlavaged left lung. Left lungs were analyzed for the connective tissue components elastin and collagen. The total number of cells recovered from the lungs of shale- and quartz-dust-exposed rats was significantly greater than the total number recovered from the lungs of unexposed rats by approximately an order of magnitude. Differences between the numbers of cells recovered when the three dust exposures are compared are probably not significant. Significant differences were detected in the elastolytic activity of lavage fluids from unexposed control and dust-exposed animals, measured by a method developed at Los Alamos utilizing peroxidase-labeled elastin. Lavage fluids from both types of shale-treated as well as quartz-treated lungs demonstrated higher elastolytic activity. Total lung collagen content (determined by colorimetric assay for hydroxyproline) was increased by approximately 3 times the unexposed control values in both shale-exposed groups and by 5.5 times the control values in the quartz-exposed group. Measurements of pulmonary elastin demonstrated that elastin content was increased in exposed lungs approximately six times that of the controls. There appeared to be little difference between the shale- and quartz-exposed groups.

29082 (LA—9640-SR, pp 42-45) **Genotoxicity of natural and synthetic oils in the Ames/Salmonella test.** Nickols, J.W.; Strniste, G.F. Feb 1983. NTIS, PC A06/MF A01.

In Los Alamos integrated oil shale health and environmental program. Status report II.

Dimethyl sulfoxide (DMSO) extracts of a variety of natural and synthetic oils and upgraded petroleum products were tested for both cytotoxic and mutagenic activities in the Ames/Salmonella bioassay. The various crude oils from different in situ processes (Occidental, Geokinetics, and Rio Blanco) all show weak but significant mutagenic activity. The 150-ton simulated MIS (LETC) oil, the coal derived medium distillate blent (SRCII), and the above ground retort composite crude oil (PSCO II) are strongly mutagenic, yet this activity in the latter oil can be completely eliminated by hydrotreatment (see PSCO UP results). The cytotoxic effects of these various oil extracts can be considerable. For example, the WILM (natural California crude oil) is 100% toxic to TA 98 at a 100 μL sample per plate, whereas the other two natural crude pe-

troleums (KCO and LCO) are minimally cytotoxic. The various shale oils tested are generally strongly cytotoxic; upgrading of the PSCO II through hydrotreatment had little effect in reducing its cytotoxic potential. The SRC II medium distillate blend was extremely toxic.

29083 (LA—9640-SR, pp 46-51) **Mutagenicity of various oil shale retort process waters in the Ames/Salmonella bioassay.** Strniste, G.F.; Nickols, J.W. Feb 1983. NTIS, PC A06/MF A01.

In Los Alamos integrated oil shale health and environmental program. Status report II.

Results of a study on the mutagenic activity of process waters from the Paraho facility (above ground retort), the Occidental and Rio Blanco facilities (modified in-situ retorts) and Geokinetic facility (in-situ retort) are presented. Mutagenic activity was seen only in those reactions which contained S9 fraction. Although each water sample was examined over a dose range of up to 300 μL, the dose response curves for mutagenically active waters were generally linear only up to sample volumes of < 100 μL. Deviations from a linear dose response can be partially accounted for by cytotoxic properties of these active waters at higher concentrations. Employing the standard plate assay, the only waters determined to be mutagenic were the highly active Paraho process water (PRHO 005) and the weakly mutagenic Occidental room 6 boiler blowdown water. Our definition for positive mutagenicity in either TA 98 or TA 100 is when the response is reproducible and linear over some portion of dose range tested, and when the maximum number of his^+ revertants induced per plate over the dose range tested equals or is greater than 1.7X our historical background mutation frequencies for either strain, which can be shown to be a statistically significant result ($p < 0.01$). As reported previously, the employment of the modified Ames procedure which incorporates a pre-incubation step has yielded positive mutagenic results for certain waters tested with TA 98 which were declared negative in activity when tested in the standard plate assay scheme. We show an example of positive activity for the Geokinetics retort room 17 process water which was negative in activity in the standard plate assay. Other process waters obtained from this particular retort burn and an Occidental process water (room 4) were negative in this modified assay in agreement with that seen in the standard plate assay.

29084 (LA—9640-SR, pp 52-53) **Genotoxicity induced by a fractionated shale oil by-product in Chinese hamster cells following metabolic activation.** Okinaka, R.T.; Strniste, G.F.; Chen, D.J. Feb 1983. NTIS, PC A06/MF A01.

In Los Alamos integrated oil shale health and environmental program. Status report II.

These studies, briefly described, were initiated to measure the genotoxic properties of a particular shale oil process water in a cultured mammalian cell system (CHO) following metabolic activation provided by rat liver homogenates (S9) or feeder layers of Syrian hamster embryo cells (SHE). The process water (Paraho 005, 06SEPT78.005) obtained from the holding tank during the surface retorting of oil shale has been shown to induce a linear dose response of ~ 100 histidine revertants/μL in the Ames/Salmonella test. The assessment of the genotoxic properties of this same complex mixture in mammalian cell cultures, however, is complicated by direct-acting components which are toxic but not mutagenic to mammalian cells. These toxic components were eliminated by an acid-base fractionation scheme in which the majority of the mutagenic moieties (as determined by the Ames test) were localized in the base-neutral fraction. The cytotoxic and mutagenic effects of this base-neutral fraction were tested on Chinese hamster cells. Results suggest a difference in the genotoxic response to shale oil components by Salmonella and Chinese hamster cells in culture following S9 activation. A similar response is observed when inactivated Syrian hamster cells serve as feeder layers (activation source) for the metabolically inert CHO cells.

29085 (LA—9640-SR, pp 58-62) **Comparison of mutagenic effects at five genetic loci.** Strniste, G.F.; Chen, D.J.; Okinaka, R.T. Feb 1983. NTIS, PC A06/MF A01.

In Los Alamos integrated oil shale health and environmental program. Status report II.

We have previously shown that near ultraviolet light (NUV) activates oil shale retort process waters which induce genotoxicity in cultured Chinese hamster ovary (CHO) cells. Since the degree of mutability of different genetic loci, as well as the type of mutation damage induced, may vary considerably for different mutagens, a mutagenesis assay system employing a variety of markers in a single cell line may be more effective in detecting the broader spectrum of mutagens of carcinogens present in complex mixtures. We have employed five drug-resistant markers to monitor mutagenesis induced in CHO cells by process water plus NUV including (1) resistance to 6-thioguanine (6TG) to measure forward mutation at the X-linked hypoxanthine-guanine phosphoribosyl transferase (HGPRT) locus; (2) resistance to 8-azaadenine (8AA) with presumptive alterations in the autosomal recessive adenine phosphoribosyl transferase (APRT) gene; (3) resistance to ouabain (OUA), a codominant marker affecting membrane Na^+/K^+ ATPase; (4) resistance to emetine (EMT); and (5) resistance to diptheria toxin (DIP), where lesions in these latter two markers affect protein synthesis. Results indicate that the qualitative responses of these various markers in CHO after exposure to two different retort process waters and NUV are in agreement with the results for these two process waters' mutagenic potential as assessed at the HGPRT locus only as previously reported. The sample of an aboveground retort process (PRHO, 6SEPT78.005) water was strongly mutagenic at all loci, whereas the true in situ retort process (GEOK, 15AUG79.104) water was a weaker mutagen when assessed under the same conditions.

29086 (LA—9640-SR, pp 62-66) **Effect of shale oil and process waters on in vitro induction of sister chromatid exchange.** Campbell, E.W.; Ray, F.A.; Deaven, L.L. Feb 1983. NTIS, PC A06/MF A01.

In Los Alamos integrated oil shale health and environmental program. Status report II.

In vitro induction of sister chromatid exchanges was performed with concentrations of oil shale products or byproducts that did not appreciably change the cell cycle traverse rate of CHO cells. The materials to be tested and bromodeoxyuridine (BUdR) were added to cell cultures for two cell cycles (29 h); during the last 2 h the cells were blocked in metaphase with colcmid (0.06 μg/mL). Metaphase chromosome preparations were made and the sister chromatids were differentiated using a fluorescent plus Giemsa technique. SCE rates were determined by counting the exchanges in 25 sec division cells from each test. The mean level of SCE's per cell in 28 control cultures was 7.67 +- 0.18. Because the shale oils have little or no solubility in aqueous medium, the samples were tested as DMSO extracts. The DMSO did not change SCE frequencies or mitotic indices. We have tested 14 process waters and the DMSO extracts of 18 oils using the methods described. The aim of this work is to give a general idea of the levels of toxicity associated with these products and byproducts so future tests can be concentrated on appropriate samples. Examples of these tests and results from them are summarized.

29087 (LA—9640-SR, pp 66-67) **Comparison of direct-acting cytogenetic and mutagenic effects of a shale oil retort process water.** Meyne, J.M.; Deaven, L.L.; Chen, D.J.; Strniste, G.F. Feb 1983. NTIS, PC A06/MF A01.

In Los Alamos integrated oil shale health and environmental program. Status report II.

Oil shale process water from an aboveground retort contains direct-acting mutagens which induce significant numbers of 6-thioguanine resistant (6-TG/sup R/) mutants in cultured human embryonic skin fibroblasts without metabolic activation. At equivalent doses of process water, less severe effects are observed in treated Chinese hamster (CHO) cells. Since many mutagenic agents are also clastogenic, we have compared the cytogenetic and mutagenic effects of an oil shale process water (PRHO 005, 06SEPT78.005) under the same experimental conditions. The results for CHO cells and the results for human fibroblasts are tabulated. The mutation enhancement index was derived by dividing the observed mutation frequency by the background mutation frequency. CHO cells demonstrated significant, dose-related increases in the frequency of chromosomal breaks observed. The frequency of tetraploid cells (including endoreduplication) was increased in both cell types but dose-related only in human fibroblasts. Although there is no quantitative correlation between mutation frequency and the frequency of either chromosomal breaks or tetraploid cells in cultures treated

with this process water, this study provides additional support to the hypothesis that many mutagens also induce chromosomal changes.

29088 (LA—9640-SR, pp 68-70) **Sister chromatid exchange (SCE) analysis in bone marrow of mice treated with shale oils and shale process waters.** Meyne, J.M.; Deaven, L.L. Feb 1983. NTIS, PC A06/MF A01.

In Los Alamos integrated oil shale health and environmental program. Status report II.

The purpose of this study is to determine if SCE provides a more sensitive method of screening for DNA damage induced by crude shale oil and process waters from retorts. Results suggest that structural aberration analysis is more sensitive than SCE analysis for evaluation of the types of DNA damage induced in murine bone marrow by shale oils and process waters.

29089 (LA—9640-SR, pp 70-74) **Effects of solubility on tumorigenesis of two shale crude oils and two natural petroleums.** Wilson, J.S.; Holland, L.M. Feb 1983. NTIS, PC A06/MF A01.

In Los Alamos integrated oil shale health and environmental program. Status report II.

Conducting in vivo tumorigenesis assays with high-viscosity, complex hydrocarbon mixtures required that the mixtures be diluted. These mixtures were samples of process-specific crude shale oils or natural petroleums. Two problems arose: (1) several of the compounds were semisolid at room temperature, while others were liquid; and (2) none were equally soluble in several test solvents. Most of our current experiments use a mixture of 30% cyclohexane - 70% acetone as the solvent/vehicle. This vehicle was neither irritating to the skin nor tumorigenic when applied three times per week for 78 weeks. However, the four test oils proved to be variably soluble in this vehicle, and the two shale oils were more soluble than either of the natural petroleums. This study was conducted in order to assess the possible contribution of solubility to overall toxicity and tumorigenesis. Each of the test oils was mixed in each of three vehicles, acetone, cyclohexane, and a mixture of 30% cyclohexane-70% acetone. All of the final samples represented 10% oil-90% vehicle mixtures. The suspension-solutions were deposited on the intrascapular area of C3Hf/Bd mice. It seems apparent that the solubility of these test oils in these vehicles has an effect on cytoxicity and tumor latency but minimal effect on overall tumor incidence. More information is needed to explain whether these are synergistic effects of the oil-solvent complexes or whether there is selective mobilization by the respective vehicles.

29090 (LA—9640-SR, pp 74-80) **Dose-response study for three shale crude oils and two natural petroleums.** Holland, L.M.; Wilson, J.S. Feb 1983. NTIS, PC A06/MF A01.

In Los Alamos integrated oil shale health and environmental program. Status report II.

The data presented here are for mice exposed by epidermal application to aliquots of several process-specific shale crude oils (Paraho, Paraho hydrotreated oil, modified in-situ, and in-situ). For comparison with the crude shale oils, two natural petroleums (KCO and LCO) and a known skin carcinogen, benzo(a)pyrene [B(a)P], were also tested. The parameters studied included tumor incidence and latency resulting from various concentrations of each test material. From these data, the relative tumorigenic potency of the shale oils and the natural petroleums was determined. The three shale oils showed different degrees of cytotoxic potency on the epidermis of exposed animals, but the natural petroleums failed to demonstrate cytotoxicity except in one mouse. Among the more important results of these studies is the demonstration of a process-dependent difference among crude shale oils. These experiments also demonstrate the effectiveness of upgrading (hydrotreating) in reducing the tumorigenic potency of one shale oil. (DMC)

29091 (LA—9640-SR, pp 80-85) **Nickel arsenide (Ni_5As_2): the relationship between its solubility and its toxicity and mutagenicity.** Gurley, L.R.; Tobey, R.A.; Valdez, J.G.; Miglio, J.J.; Cox, S.H.; Barham, S.S. Feb 1983. NTIS, PC A06/MF A01.

In Los Alamos integrated oil shale health and environmental program. Status report II.

Nickel arsenides may be formed during the oil shale retorting process. To determine whether fugitive nickel arsenides from an oil shale retort could pose a threat to personnel in the workplace or to other living organisms in the environment, a program to study the toxicity of nickel arsenides has been initiated. Six stable nickel arsenides (Ni_5As_2, Ni_2As, $Ni_{11}As_8$, NiAs, $NiAs_2$, and NiAsS) are considered possible species for consideration. Studies have now been made on the toxicity of Ni_5As_2. Arsenic leaching studies and independent nickel cellular deposition suggest that both nickel and arsenic are solubilized in growth medium and one or both of their soluble products are responsible for the toxic effects of Ni_5As_2. To determine the true toxic level of the soluble product of Ni_5As_2, the culture medium was exposed to Ni_5As_2 powder for 24 h. The Ni_5As_2 particles were then removed, and the soluble nickel and arsenic remaining in solution in the medium were measured by atomic absorption. The effect of the soluble Ni_5As_2 on CHO cell-culture growth was measured. It is concluded from the results to date that the soluble product of Ni_5As_2 is acutely toxic to cells at low concentrations (less than 1 ppM) but not mutagenic. These results will provide a comparison for similar studies of the toxic effects of nickel subarsenide ($Ni_{11}As_8$) which is a suspected carcinogen.

0409 Waste Research And Management

REFER ALSO TO CITATION(S) 28866

0410 Enviromental Aspects

REFER ALSO TO CITATION(S) 30357, 30533, 30534, 30535, 30536, 30537, 30545, 30550, 30551, 30552, 30553

29092 (LA—9479-PR, pp 121-124) **Analytical chemistry of oil shale.** Spall, W.D. Oct 1982. NTIS, PC A08/MF A01.

In Los Alamos Life Sciences Division's biomedical and environmental research programs. Progress report, January-December 1981.

Three topics in the general theme of the analytical chemistry of oil shale are discussed. These include solvent extraction studies of oil shale materials in order to determine the compounds responsible for observed biological effects; the evaluation of air and dust samples derived from oil shale; and the fractionation and analysis of oil shale retort water. (DLS)

29093 (LA—9640-SR) **Los Alamos integrated oil shale health and environmental program. Status report II.** Holland, L.M.; Stafford, C.G.; Strniste, G.F.; Griffith, M.F. (comps.). (Los Alamos National Lab., NM (USA)). Feb 1983. Contract W-7405-ENG-36. 102p. NTIS, PC A06/MF A01. Order Number DE83010138.

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This report summarizes the Los Alamos National Laboratory research activities addressing health and environmental concerns related to the developing US oil shale industry for calendar year 1981. Individual projects are carried out by investigators in several groups within the Laboratory's Life Sciences (LS), Health (H), and Chemistry (CHM) Divisions, with support from the Office of Health and Environmental Research and the Assistant Secretary for Fossil Energy of the United States Department of Energy (DOE). The technical reports included in this document are organized on the basis of materials of concern rather than on Laboratory organizational structure. Site- and technology-specific information is included in those instances where it is important to the understanding of the problem. Certain of the projects address more generic or fundamental questions common to most technologies, but each study, whether generic or applied, fits within the health and environmental concerns stated in the DOE Oil Shale Research Development and Demonstration (RD and D) Plan. Separate abstracts have been prepared for each of the 21 technical reports for inclusion in the Energy Data Base.

29094 (LA—9640-SR, pp 19-23) **Piceance Basin mule deer study.** Garrott, R.A.; White, G.C. Feb 1983. NTIS, PC A06/MF A01.

In Los Alamos integrated oil shale health and environmental program. Status report II.

This report summarizes the results of the first year of field work on the Piceance Basin mule deer study. The primary objectives of the study, which is funded by the US Department of Energy, are to determine migration pathways, seasonal movements, and mortality of mule deer inhabiting areas being developed as Federal Prototype Oil Shale leasing sites in the Piceance Basin of northwest Colorado. There is a clear need for the information that will be forthcoming from this study because the potential impact of full-field development of oil shale resources on Piceance deer is a sensitive political and public concern. The Piceance Basin is the location of the largest migratory population of mule deer in the world. Information on deer migration patterns and movements are needed to determine critical relationships to habitat that may be impacted by oil shale development and to provide a rationale for mitigating impacts, should they occur.

29095 (LA—9640-SR, pp 92-99) **Assessment and control of water contamination associated with shale oil extraction and processing.** Wagner, P.; Peterson, E.J. Feb 1983. NTIS, PC A06/MF A01.

In Los Alamos integrated oil shale health and environmental program. Status report II.

Water quality concerns associated with shale oil extraction arise because of the physical and chemical disturbance of the oil shale matrix on the macroscopic and microscopic levels. This research program identified likely routes for pollutant mobility and water degradation, and then used knowledge of the chemical system to investigate mitigating strategies. This summary focusses on potential water quality problems associated with modified in situ (MIS) retort abandonment. These investigations have dealt with the nature, extent, transport, and fate of contaminants mobilized as a function of waste form and retort parameters. The impact of in situ leaching was estimated by comparing pre- and post-development groundwater quality near MIS retorts with water quality criteria using Logan Wash leaching results. Predevelopment ground waters are unsuitable for many uses. These waters are presently unacceptable as a drinking water supply (boron, fluoride, iron, manganese) and as an agricultural supply (boron, fluoride, lithium, molybdenum) due to elevated concentrations of some elements. Results of this study reveal that intermingling of upper and lower aquifer waters will not alter the acceptability of the resulting waters for projected beneficial uses. Second, they demonstrate that certain trace elements, such as vanadium, selenium, and lead, may be significantly elevated above background concentrations and may have to be removed before the waters can be used.

05 NUCLEAR FUELS

0502 Exploration

REFER ALSO TO CITATION(S) 29060

29096 (GJBX—2(83)) **Multidisciplinary studies of a uranium deposit in the San Juan Basin, New Mexico. National Uranium Resource Evaluation.** Sayala, D.; Ward, D.L. (Bendix Field Engineering Corp., Grand Junction, CO (USA). Grand Junction Operations). Feb 1983. Contract AC13-76GJ01664. 330p. NTIS, PC A11/MF A01. Order Number DE83008320.

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This report presents the results of multidisciplinary investigations of a uranium deposit in the San Juan Basin, New Mexico. The investigations were begun in 1979 by Bendix Field Engineering Corporation as part of the National Uranium Resource Evaluation program. The report is organized into individual sections that elucidate methods and results for the various approaches taken, namely, geologic, mineralogical, geophysical, geochemical, and emanometric studies. These studies are aimed at characerizing the deposit and aiding in the detection of similar deposits in the San Juan Basin. Each section has been abstracted and indexed for the Energy Data Base.

29097 (GJBX—2(83), pp 7-61) **Geologic studies.** Ward, D.L. Feb 1983. NTIS, PC A11/MF A01.

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In Multidisciplinary studies of a uranium deposit in the San Juan Basin, New Mexico. National Uranium Resource Evaluation.

Geologic studies consisted of the synthesis and interpretation of regional and local structures, evaluation of subsurface log information, and the interpretation of sedimentological conditions--all of which have influenced the deposition of uranium in the project area. Objectives of geologic studies in the project area were as follows: (1) To characterize the uranium deposit and its host rock; (2) to determine the sedimentological and structural controls that localizaed the deposit; and (3) to identify the combination of evidences that could be used to detect the deposit. The scope of geologic studies in this report is limited to a small area of less than two square miles, and to subsurface information compiled from about 200 drill holes. Subsurface information for stratigraphic, sedimentological, and structural analyses was obtained from gamma-ray, self potential, and resistivity drill-hole logs; and from cores and geophysical surveys conducted over the project area. A vast amount of published literature is available on the San Juan Basin and particularly on the Grants Mineral Belt. However, for the purpose of this study, regional tectonics that affected the project uranium deposit are briefly reviewed. 31 figures.

29098 (GJBX—2(83), pp 63-110) **Mineralogical studies.** Austin, S.R. Feb 1983. NTIS, PC A11/MF A01.

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In Multidisciplinary studies of a uranium deposit in the San Juan Basin, New Mexico. National Uranium Resource Evaluation.

The mineralogy of WC-series cores from the project area uranium deposit in the San Juan Basin, New Mexico was studied with respect to the deposit and to the paleohydrologic and present hydrologic gradients. Bulk clay analyses, authigenic clay coatings on detrital grains, sulfur minerals, ferric oxide minerals, carbonate minerals, and detrital magnetite-ilmenite were investigated. Among the clays, chlorite/illite seem to offer some indication of the deposit location. More frequent clay coatings are found in the favorable ore horizon along the paleogradient than along the present gradient. Barite is more abundant in the favorable horizon and near ore than elsewhere. Pyrite and other sulfide minerals are relatively sparse in and near the deposit compared to areas away from the deposit. More than two generations of ferric oxide minerals are present in the area and these are deleted in samples nearest ore down the present gradient. Carbonate minerals aremore abundant in lower parts of the favorable zone. 8 figures, 2 tables.

29099 (GJBX—2(83), pp 111-134) **Geophysical studies.** Johnson, V.C.; Farley, W.G. Feb 1983. NTIS, PC A11/MF A01.

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In Multidisciplinary studies of a uranium deposit in the San Juan Basin, New Mexico. National Uranium Resource Evaluation.

This section reports on investigations into geophysical responses associated with uranium deposits in the San Juan Basin project area. The objective of these investigations was to identify physical properties that characterize the deposits and their geologic surroundings. Regional aerial magnetic and gravity data indicate a major northeast-trending structure (shear zone) in the Precambrian basement rocks. This structure played a major role in the formation of a basin that facilitated thickening of the Westwater Canyon Member and localized the uranium deposit. Regional surveys of gravity and magnetics are cost-effective, as large areas can be scanned for favorable targets in relatively short time. A detailed aerial magnetic survey successfully identified the northeast trending basement faults that have influenced drainage in the Morrison Formation; on this basis, this method is recommended for delineating subregional targets for further exploratory work. A reflection-seismic survey was conducted along zigzag lines crossing the deposit. Data from this survey delineated a north-trending synclinal structure (paleochannel), identified a northwest-trending graben structure in the basement, and demarcated the age and extent of the faults; all these structures have apparently influenced the localization of the uranium deposit. The seismic method also proved helpful in estimating the depth of the Morrison Formation; thus, this method may be helpful in cost-estimation for exploratory drilling. In general, geophysical data used in conjunction with geologic data

helped in explaining the deformational history of the area, which is useful for identifying potential targets for exploratory drilling.

29100 (GJBX—2(83), pp 135-183) **Geochemical studies.** Sayala, D. Feb 1983. NTIS, PC A11/MF A01.

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In Multidisciplinary studies of a uranium deposit in the San Juan Basin, New Mexico. National Uranium Resource Evaluation.

Geochemial studies at the San Juan Basin site were focused on the geochemistry of the Westwater Canyon Member of the Morrison Formation, which hosts the uranium deposit. Twelve core holes (WC Series) were drilled along the paleohydrologic and present hydrologic gradients and criss-crossing the outlined deposit. The objectives of this study were as follows: (1) to identify any geochemical halos around the deposit; (2) to study geochemical changes along the paleohydrologic and present hydrologic gradients; and (3) to identify elements that can serve as pathfinders to uranium deposits in the Westwater Canyon sandstone. The results of core geochemical studies were also applied to the problem of ore genesis. Generally, any geochemical signatures or patterns in the sedimentary rocks were grouped as supergene (secondary) signatures. These signatures were related to the processes contemporary to and following uranium mineralization that occurred during and after the consolidation of the host rocks. The possible contribution of detrital minerals to the geochemical signatures in the Westwater Canyon was also expected. Core geochemistry is considered an essential link in the exploration systems approach to the formulation of drilling plans and the ultimate discovery of blind uranium deposits in sedimentary rocks. Published literature pertinent to the geochemistry of uranium deposits of the San Juan Basin indicates various geochemical associations. These are summarized in Table V-1. 3 figures, 3 tables.

29101 (GJBX—2(83), pp 185-213) **Emanometric studies.** Lindgren, J.E. Feb 1983. NTIS, PC A11/MF A01.

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In Multidisciplinary studies of a uranium deposit in the San Juan Basin, New Mexico. National Uranium Resource Evaluation.

In the project area, the uranium deposit is at depths greater than 610 m (2000 ft) and is overlain by shales, siltstones, mudstones, and sandstones of the Brushy Basin, Dakota, Mancos, and Mesa Verde stratigraphic units. Therefore radiogenic anomalies generated by the deposit are probably not detectable in surface soils. For this reason, groundwater emanometry is expected to be more effective than soil emanometry in the exploration for deep-seated uranium deposits. Groundwater samples from the reconnaissance (wide-spaced) drill holes were collected at depths above, below, and within the deposit. Emanometric studies included helium, radon, and radon-decay surveys in conjunction with analyses of uranium and its activity ratios (U-234/U-238) in borehole waters. Generally, groundwater radon anomalies are localized near the deposit, whereas helium anomalies are found down the hydrologic gradient from the deposit. Uranium and its activity ratios in groundwater indicate a movement of uranium from west to east. The large variation in U-234/U-238 activity ratios in the deposit suggests a fairly slow-moving system on a 105-year time-scale. The measurement of helium, as compared to uranium activity ratios, is the more cost-effective emanometric method for subregional exploration; radon measurement is the most effective method in the detailed exploration phase.

29102 (GJBX—2(83), pp 215-226) **Integrated studies.** Sayala, D.;. Feb 1983. NTIS, PC A11/MF A01.

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In Multidisciplinary studies of a uranium deposit in the San Juan Basin, New Mexico. National Uranium Resource Evaluation.

In the exploration for and discovery of a uranium deposit, an integrated approach consisting of geologic, mineralogical, geophysical, geochemical, and emanometric surveys and techniques is considered very effective. Although each survey or technique has its own characteristics, the results of one usually corroborate and complement those of others; thus, the combined results of an exploration program can enhance the probability of discovering a uranium deposit. Based on the results of the integrated approach used and the logistics of the various surveys and techniques, a systematic five-phase exploration program is proposed for deep sandstone-type uranium deposits, wherein the initial phase relies heavily on geophysical methods. 1 figure.

0503 Mining

29103 (UCID—19266) **Chapter 2: uranium mines and mills.** O'Connell, W.J. (Lawrence Livermore National Lab., CA (USA)). Mar 1983. Contract W-7405-ENG-48. 19p. NTIS, PC A02/MF A01. Order Number DE83009698.

This chapter will be included in a larger ASCE Committee Report. Uranium mining production is split between underground and open pit mines. Mills are sized to produce yellowcake concentrate from hundreds to thousands of tons of ore per day. Miner's health and safety, and environmental protection are key concerns in design. Standards are set by the US Mine Safety and Health Administration, the EPA, NRC, DOT, the states, and national standards organizations. International guidance and standards are extensive and based on mining experience in many nations.

0504 Feed Processing

REFER ALSO TO CITATION(S) 29103

29104 (CONF-830317—2) **Characterization of molybdenum interfacial crud in a uranium mill that employs tertiary-amine solvent extraction.** Moyer, B.; McDowell, W.J. (Oak Ridge National Lab., TN (USA)). 1983. Contract W-7405-ENG-26. 15p. NTIS, PC A02/MF A01. Order Number DE83009770.

From TMS/AIME meeting; Atlanta, GA, USA (6 Mar 1983).

In the present work, samples of a molybdenum-caused green gummy interfacial crud from an operating western US uranium mill have been physically and chemically examined. Formaton of cruds of this description has been a long-standing problem in the use of tertiary amine solvent extraction for the recovery of uranium from low-grade ores (Amex Process). The crud is essentially an organic-continuous dispersion containing about 10 wt % aqueous droplets and about 37 wt % greenish-yellow crystalline solids suspended in kerosene-amine process solvent. The greenish-yellow crystals were found to be a previously unknown double salt of tertiary amine molybdophosphate with three tertiary amine chlorides having the empirical formula $(R_3NH)_3[PMo_{12}O_{40}].3(R_3NH)Cl$. To confirm the identification of the compound, a pure trioctylamine (TOA) analog was synthesized. In laboratory extraction experiments, it was demonstrated that organic-soluble amine molydophosphate forms slowly upon contact of TOA solvent with dilute sulfuric acid solutions containing low concentrations of molybdate and phosphate. If the organic solutions of amine molybdophosphate were then contacted with aqueous NaCl solutions, a greenish-yellow precipitate of $(TOAH)_3[PMo_{12}O_{40}].3(TOAH)Cl$ formed at the interface. The proposed mechanism for the formation of the crud under process conditions involves build up of molybdenum in the solvent, followed by reaction with extracted phosphate to give dissolved amine molybdophosphate. The amine molybdophosphate then co-crystallizes with amine chloride, formed during the stripping cycle, to give the insoluble double salt, which precipitates as a layer of small particles at the interface. The proposed solution to the problem is the use of branched-chain, instead of straight-chain, tertiary amine extractants under the expectation that branching would increase the solubility of the double salt. 2 figures, 5 tables.

29105 (GKSS—82/E/36) **Uranium extraction from seawater.** Koske, P.H.; Ohlrogge, K.; Denzinger, H. (GKSS-Forschungszentrum Geesthacht G.m.b.H., Geesthacht-Tesperhude (Germany, F.R.)). 1982. 7p. (In German). Also published in: MT (Meerestech.) (1982) v. 13(3) p. 63-69.

Besides basic considerations about the problem of uranium extraction from seawater, system studies on process engineering and marine technology approaches are presented. In addition, the present and future developments in the Federal Republic of Germany are discussed in somewhat more detail.

0505 Enrichment

29108 **Isotope separation by laser means.** Boyer, K.; Cotter, T.P.; Greiner, N.R.; Jensen, R.J.; Robinson, C.P. (to Dept. of Energy). US Patent 4,334,883. 15 Jun 1982. Filed date 14 Aug 1973. vp.

PAT-APPL-387859.

A process for separating isotopes by selective excitation of isotopic species of a volatile compound by tuned laser light. A highly cooled gas of the volatile compound is produced in which the isotopic shift is sharpened and defined. Before substantial condensation occurs, the cooled gas is irradiated with laser light precisely tuned to a desired wavelength to selectively excite a particular isotopic species in the cooled gas. The laser light may impart sufficient energy to the excited species to cause it to undergo photochemical reaction or even to photoionize. Alternatively, a two-photon irradiation may be applied to the cooled gas to induce photochemical reaction or photoionization. The process is particularly applicable to the separation of isotopes of uranium and plutonium.

0506 By-products

29107 **Process for recovering uranium from waste hydrocarbon oils containing the same.** Conrad, M.C.; Getz, P.A.; Hickman, J.E.; Payne, L.D. US Patent Application 6-393,230. 29 Jun 1982. 8p. Contract W-7405-ENG-26.

The invention is a process for the recovery of uranium from uranium-bearing hydrocarbon oils containing carboxylic acid as a degradation product. In one aspect, the invention comprises providing an emulsion of water and the oil, heating the same to a temperature effecting conversion of the emulsion to an organic phase and to an acidic aqueous phase containing uranium carboxylate, and recovering the uranium from the aqueous phase. The process is effective, simple and comparatively inexpensive. It avoids the use of toxic reagents and the formation of undesirable intermediates.

0507 Fuels Production And Properties

29108 **Method of dispensing droplets to penetration-resistive mediums.** Fowler, V.L.; Ryon, A.D.; Haas, P.A. US Patent Application 6-387,063. 10 Jun 1982. 20p. Contract W-7405-ENG-26.

Uniform, monosized microspheroids are produced in a gelation medium characterized by a high resistance to surface penetration by reducing the effect of impact on entry of the droplets into the medium by contacting the droplet with a stream of medium and by introducing the resulting stream into a gelation column.

0508 Spent Fuels Reprocessing

REFER ALSO TO CITATION(S) 29210, 29211, 30769

29109 **(ORNL/TM—8613) Consolidated Fuel Reprocessing Program. Progress report, October 1-December 31, 1982.** (Oak Ridge National Lab., TN (USA)). Mar 1983. Contract W-7405-ENG-26. 43p. NTIS, PC A03/MF A01. Order Number DE83010449.

All research and development on fuel reprocessing in the United States is managed under the Consolidated Fuel Reprocessing Program centered at Oak Ridge National Laboratory. Technical progress is reported in overview fashion on the following projects: process and engineering R and D; engineering systems; integrated equipment test facility operations; instrumentation and controls; HTGR fuel reprocessing; and strategic planning and analysis.

29110 **(RHO-PB-SR—10-B-CP) Chemical processing monthly report.** (Rockwell International Corp., Richland, WA (USA). Rockwell Hanford Operations). Mar 1983. Contract AC06-77RL01030. 54p. NTIS, PC A04/MF A01. Order Number DE83011043.

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Chemical processing highlights for March 1983 are as follows: (1) Implementation of the Safeguards Program Phasing Plan was completed ahead of schedule. Programmatic responsibility for safeguards has been distributed to the KA K1, K4, and K6 end functions. (2) The Process Facility Modification (PFM) Program Management team, including PFM Project Manager - PFM Design, and PFM Project Manager - Systems, were selected. (3) The A, B, C, D shift operation at the PUREX Plant was initiated on March 14.

29111 **Can the administration sell reprocessing.** Walsh, J. *Science (Washington, D.C.);* **218**: 32-34(1 Oct 1982).

The Reagan administration policy on nuclear energy is viewed as it relates to fuel reprocessing and to the administration's desire to bring the Barnwell, SC plant on-stream. The proliferation issue as it relates to reprocessing is countered with the claim that activation of Barnwell for reprocessing would significantly reduce current problems with high-level radioactive wastes, since such wastes are converted by reprocessing into a form more readily disposable. Many of the current economic, political, and technological uncertainties surrounding reprocessing, particularly as they would relate to the Barnwell facility, are explored. Incentives which are necessary to interest private industry in fuel reprocessing either now or in the future are explored. Various points raised in a report originating at Argonne National Laboratory concerning the technological aspects of Barnwell are aired with opposing remarks by Shelby Brown, DOE Assistant Secretary for nuclear energy. (BLM)

29112 **Operational experience in remote handling during the reprocessing of PFR fuel elements.** Bailey, G. (Dounreay Nuclear Power Development Establishment, Caithness, Scotland). pp 413-421 of Proceedings of the ANS topical meeting on the treatment and handling of radioactive wastes. Columbus, OH; Battelle Press (1982).

From ANS topical meeting on treatment and handling of radioactive wastes; Richland, WA, USA (19 Apr 1982).

The reprocessing of PFR fuel elements at DNE was achieved using new techniques of remote handling as well as standard manipulative procedures. This engineering balance was justified in the successful completion of two PFR reprocessing campaigns, where the personnel involved received low radiation doses. Development work is progressing along the lines of minimizing in-cell equipment, improved remote viewing, and the modular assembly and construction of equipment and cells.

29113 **Equilibrium theory of a pressure swing adsorption process.** Chan, Y.N.I.; Hill, F.B.; Wong, Y.W. (Brookhaven National Lab., Upton, NY). *Chemical Engineering Science;* **36**: 243-251(1981).

An equilibrium theory of the separation of two-component gaseous mixtures via the pressure swing adsorption process known as heatless adsorption is presented. Both components of the mixture are adsorbable. One is present at a trace level and is preferentially adsorbed. Principal predictions of the theory for the condition of complete removal of the trace component from the high pressure product stream when using the least possible amount of adsorbent are as follows. When the separation factor is large, high recovery of purified high pressure product is obtained and blowdown and purge losses are small. Recovery is increased and losses decreased by increasing the pressure ratio. Conversely, recovery of the purified high pressure product is small and blowdown and purge losses are large when the separation factor is small. In this case the use of high pressure ratios does not improve performance. The trace level component in the combined blowdown and purge stream is derived increasingly from the blowdown as the pressure ratio is increased.

29114 **Flow over circular weirs in a centrifugal field.** Leonard, R.A.; Pelto, R.H.; Ziegler, A.A.; Bernstein, G.J. (Argonne National Lab., IL). *Canadian Journal of Chemistry;* **58**: 531-534(Aug 1980). Contract W-31-109-ENG-38.

Liquid height over a circular weir in a cenrifugal field has been measured as a function of the flow over the weir for baffle configurations of great practical importance in the design of centrifugal contractors for solvent extraction. An existing correlation was tested and extended so that it can now be used for both baffle designs. The baffle design in which the baffle ends at the same radius

as the weir, i.e., a baffle flush with the weir, is superior because, when Coriolis effects are significant, the liquid height over the weir is less affected by flow rate.

0509 Transport And Storage

REFER ALSO TO CITATION(S) 29129

29115 **(ORNL/CSD/TM—150) Summary report on optimized designs for shipping casks containing 2-, 3-, 5-, 7-, or 10-year-old PWR spent fuel.** Bucholz, J.A. (Oak Ridge National Lab., TN (USA)). Apr 1983. Contract W-7405-ENG-26. 34p. NTIS, PC A03/MF A01. Order Number DE83010219.

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The purpose of this study was to develop new conceptual designs for large Pb, Fe, and U-shielded spent fuel casks which have been optimized for the shipment of 2-, 3-, 5-, 7-, or 10-year-old PWR spent fuel assemblies. Design specifications for about 100 cases of potential interest are presented along with a brief 20-page synopsis of the associated analyses. Optimized shielding requirements are presented for each type of cask as a function of the age of the spent fuel and the number of assemblies in the cask. With respect to criticality, a new type of inherently subcritical fuel assembly separator is described which uses hollow, borated stainless-steel tubes in the wall-forming structure between the assemblies. Steady-state and transient heat transfer analyses for casks under nominal and accident conditions were performed using the SCOPE code for Shipping Cask Optimization and Parametric Evaluation. Based on criticality, shielding, and heat transfer considerations, it appears that optimized cask designs could be developed to carry 15 to 18 five-year-old PWR fuel assemblies or as many as 18 to 21 ten-year-old PWR fuel assemblies. 4 figures, 4 tables.

29116 **(ORNL/TM—8347/R1) Safety-analysis report for packaging: the ORNL DOT specification 20WC-5 - special form packaging.** Schaich, R.W. (Oak Ridge National Lab., TN (USA)). Mar 1983. Contract W-7405-ENG-26. 71p. NTIS, PC A04/MF A01. Order Number DE83010978.

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The ORNL DOT Specification 20WC-5 - Special Form Packaging was fabricated at the Oak Ridge National Laboratory (ORNL) for the transport of large quantities of solid non-fissile radioactive materials in special form. the package was evaluated on the basis of tests performed at Sandia National Laboratories, Albuquerque, New Mexico (formerly Sandia Corporation), on an identical fire and impact shield and special form tests performed on a variety of stainless steel capsules at ORNL by Operations Division personnel. The results of these evaluations demonstrate that the package is in compliance with the applicable regulations for the transport of large quantities of non-fissile radioactive materials in special form. 7 figures.

29117 **(PNL-SA—8508) Experience with fuel damage from abnormal conditions in handling and transport.** Bailey, W.J.; Langstaff, D.C. (Pacific Northwest Lab., Richland, WA (USA); Columbia Engineers Service, Inc., Kennewick, WA (USA)). 15 Oct 1980. Contract AC06-76RL01830. 9p. (CONF-801115—49). NTIS, PC A02/MF A01. Order Number DE83003654.

From 6. international symposium on packaging and transporting radioactive material; Berlin, F.R. Germany (10 Nov 1980).

Very few fuel bundles have sustained major mechanical damage because of handling operations. Little is known about damage to fuel during shipments; however, such damage, if any, is apparently minor. In most cases involving damage from handling, it appears that the result was minor degradation of fuel-bundle components and no breaching of the fuel-rod cladding or release of radioactive gases, even in those cases where fuel bundles were dropped as much as 1.5 to 9 meters through water and impacted on other fuel bundles or the bottom of the spent-fuel storage pool.

29118 **Risk assessment for the transportation of radioactive zeolite liners.** Gallucci, R.H.V. (Pacific Northwest Lab., Richland, WA). pp 530-534 of Proceedings of the ANS topical meeting on the treatment and handling of radioactive wastes. Columbus, OH; Battelle Press (1982).

From ANS topical meeting on treatment and handling of radioactive wastes; Richland, WA, USA (19 Apr 1982).

The accident risk is estimated for the shipment of two zeolite liners containing radioactive cesium and strontium. Each liner, assumed to hold 68,200 Ci and sealed inside a CNS 1 to 13C, type-B shipping cask, is transported by truck over a 4200-km route. The risk to the population along the route is calculated for potential transportation accidents involving fire, impact, and puncture forces. The total risk is 5.3E-7 man-rem (50-year inhalation dose) and the maximum dose (from the least-likely accident) is 0.7 man-rem. Both estimates are less than 0.1% of comparable risk measures for natural background radiation and spent fuel shipment accidents.

0510 Marketing And Economics

REFER ALSO TO CITATION(S) 29203, 29206, 29217

29119 **(DOE/EIA—0387) World uranium supply and demand: impact of Federal policies.** (USDOE Energy Information Administration, Washington, DC. Office of Coal, Nuclear, Electric and Alternate Fuels). Mar 1983. 222p. NTIS, PC A10/MF A01. Order Number DE83010207.

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Background information is provided describing the Federal Government's role in the uranium industry. The current status of the domestic industry is reviewed. An analytical framework is presented. The future market under current policy is characterized, followed by estimates of the effects of the policy alternatives. Finally, the current uranium data collection efforts are reviewed for adequacy of monitoring the domestic uranium production industry. Seven appendiences provide additional details and reviewers' comments.

0520 Waste Management

REFER ALSO TO CITATION(S) 29246, 29247, 29248, 29249, 29250, 29251, 29252, 29253, 29256, 29257, 29258, 29558, 29886, 29936, 29937, 29938, 29939, 29941, 29967, 29968, 29969, 29970, 29971, 29972, 29973, 29974, 29975, 29976, 29977, 29978, 29988, 29994, 30017, 30074, 30317, 30374, 30589, 30590, 30591, 30592, 30593, 30595, 30596, 30597, 30598, 30602, 30603

29120 **(AEEW-R—1512) Incorporation of low and medium level radioactive wastes (solids and liquids) in cement. 2nd six-monthly report July-December 1981.** Capp, P.D. (UKAEA Atomic Energy Establishment, Winfrith). Feb 1982. 18p. NTIS (US Sales Only), PC A02/MF A01. Order Number DE83700405.

Progress in the study of waste fixation in cement is reported. Laboratory work has included studies of the long-term stability of formulations and the incorporation of organic ion-exchange resins in cement. Mixing plant trials are reported, and a programme of future work is outlined.

29121 **(AERE-G—2216) Programme of research into the management and storage of radioactive waste. Nuclide migration and mathematical modelling.** (UKAEA Atomic Energy Research Establishment, Harwell. Chemical Technology Div.). Jun 1982. 10p. NTIS (US Sales Only), PC A02/MF A01. Order Number DE83700406.

The report falls under the headings: nuclide migration studies (nuclide-rock interactions; physico-chemical effects (permeability, diffusion coefficients and porosity); field experiments; and groundwater dating); mathematical modelling (calculation of steady groundwater flows using NAMMU; radionuclide-migration: the program NAMTAR; matrix diffusion; and fractured media).

29122 (AERE-G—2352) Programme of research into the management and storage of radioactive waste. Thermal phenomena in crystalline rock. (UKAEA Atomic Energy Research Establishment, Harwell. Chemical Technology Div.). Apr 1982. 3p. NTIS (US Sales Only), PC A02/MF A01. Order Number DE83700407.

The report falls under the headings: heat transfer; effective permeability (of rock, for ground water flow); radionuclide retardation (water flow in fractured rock).

29123 (CONF-8110268—1) Diffusion of neptunyl(V) and pertechnetate ions in marine sediments. Schreiner, F.; Fried, S.; Friedman, A. (Argonne National Lab., IL (USA)). 1981. Contract W-31-109-ENG-38. 10p. NTIS, PC A02/MF A01. Order Number DE83010637.

From Subseabed disposal program annual workshop; Denver, CO, USA (27 Oct 1981).

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The diffusion of the $^{235}NpO_2^+$ and /sup 95m/TcO_4^- ions has been measured directly in sample cylinders of two different sediments from the floor of the deep sea. In smectite-rich sediment not shielded from contact with atmospheric oxygen the following values were obtained for the effective diffusion coefficients of neptunyl and pertechnetate ions, respectively: D/sub eff/(NpO_2^+) = 1.5 x 10^{-8} cm^2s^{-1} and D/sub eff/(TcO_4^-) = 3.2 x 10^{-6} cm^2s^{-1}. Under anoxic conditions in sediment with known reducing properties, the pertechnetate ion appears to undergo slow reduction and the effective diffusion coefficient of the reduced species of D/sub eff/(Tc,red) = 1.1 x 10^{-10} cm^2s^{-1} reflects a substantial decrease of the mobility of the lower-valent technetium. 5 figures.

29124 (DOE/ET/46634—1) State of Wisconsin Ad Hoc committee on radioactive waste management. Final report. (Wisconsin State Government, Madison (USA)). 18 Feb 1983. Contract FG02-81ET46634. 164p. NTIS, PC A08/MF A01. Order Number DE83008373.

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Part I describes the activities undertaken under the Grant with respect to Wisconsin's role in radioactive waste management.

29125 (DOE/TIC—3387-S1) Low-level radioactive waste. McLaren, L.H. (ed.). (Department of Energy, Oak Ridge, TN (USA). Technical Information Center). Mar 1983. 144p. NTIS, PC A07/MF A01. Order Number DE83007212.

This bibliography contains information on low-level radioactive waste included in the Department of Energy's Energy Data Base for January through December 1982. The abstracts are grouped by subject category as shown in the table of contents. Entries in the subject index also facilitate access by subject, e.g., Low-Level Radioactive Wastes/Transport. Within each category the arrangement is by report number for reports, followed by nonreports in reverse chronological order. These citations are to research reports, journal articles, books, patents, theses, and conference papers from worldwide sources. Five indexes, each proceded by a brief description, are provided: Corporate Author, Personal Author, Subject, Contract Number, and Report Number. 492 references.

29126 (DP—82-157-3) Long-term high-level waste technology. Composite quarterly technical report, July-September 1982. Cornman, W.R. (comp.). (Du Pont de Nemours (E.I.) and Co., Aiken, SC (USA). Savannah River Lab.). Feb 1983. Contract AC09-76SR00001. 41p. NTIS, PC A02/MF A01. Order Number DE83010987.

This series of reports summarizes research and development studies on the immobilization of high-level wastes from the chemical reprocessing of nuclear reactor fuels. Immobilization of the wastes (defense and commercial) consists of placing them in a high-integrity form with a very low potential for radionuclide release. Immobilization of commercial wastes is being considered on a contingency basis in the event that reprocessing is resumed. The basic plan for meeting the goal of immobilization of the DOE high-level wastes is (1) to develop technology to support a realistic choice of waste form alternatives for each of the three (SRP, ICPP, and RHO) DOE sites, (2) to develop product and processing technology with sufficient scaleup to provide design data for full-scale facilities, and (3) to support R and D for construction and operation of immobilization facilities. Most of the existing high-level nuclear wastes in the United States have been generated in defense activities of DOE at the Savannah River Plant (SRP), Aiken, SC; at Hanford, WA; and at the Idaho Chemical Processing Plant. An inventory of approximately 90 million gallons of high-level defense waste is on hand with a continuous annual production rate of 0.5 to 1.0 million gallons.

29127 (DP—1636) Precipitation process for supernate decontamination. Lee, L.M.; Kilpatrick, L.L. (Du Pont de Nemours (E.I.) and Co., Aiken, SC (USA). Savannah River Lab.). Nov 1982. Contract AC09-76SR00001. 35p. NTIS, PC A03/MF A01. Order Number DE83010815.

A precipitation and adsorption process has been developed to remove cesium, strontium, and plutonium from water-soluble, high-level radioactive waste. An existing waste tank serves as the reaction vessel and the process begins with the addition of a solution of sodium tetraphenylborate and a slurry of sodium titanate to the contained waste salt solution. Sodium tetraphenylborate precipitates the cesium and sodium titanate adsorbs the strontium and plutonium. The precipitate/adsorbate is then separated from the decontaminated salt solution by crossflow filtration. This new process offers significant capital savings over an earlier ion exchange process for salt decontamination. Chemical and small-scale engineering studies with actual waste are reported. The effect of many varisbles on the decontamination factors and filter performance are defined.

29128 (EGG-M—06183) State and Federal activities on low-level waste. (EG and G Idaho, Inc., Idaho Falls (USA)). 1983. Contract AC07-76ID01570. 7p. (CONF-830347—1). NTIS, PC A02/MF A01. Order Number DE83010397.

From Atomic industrial forum fuel cycle conference; Kansas City, MO, USA (20 Mar 1983).

With the passage of the Low-Level Waste Policy Act in December 1980, the states have assumed the management responsibility and the federal government has become a facilitator. State and Federal roles in regulation have not altered. This paper reviews the developments over the last two years to point out the progress made and critical steps that lie ahead. Both technological and political aspects are covered, and a conclusion is presented with a look to the future. Since compact development in the tool chosen by the politicans for low-level waste management, the author reviews the present status starting with the northwest compact which has been introduced into the House and Senate and is subject to hearings. The past two years have seen real progress in technology in the broadest sense. An information development and dissemination system was established in 1978 wih the state-by-state assessment of low-level waste disposal. Annual examinations have been made through 1981 which enables one to understand the generation of low-level wastes. Policy level planning by states can be supported by the base level of information available. Incineration of dry active waste and other non-fuel cycle waste is ready to be fully accepted. Much work has been done on volume reduction of liquids. The increased understanding of the ways to make a disposal site work represents a major technolological improvement. Within the DOE system, there is beginning to be a real understanding of the critical parameters in disposal site performance in the East. (ATT)

29129 (GA-A—17053) Monitored retrievable storage of nuclear waste in the US. Ganley, J.T.; Morissette, R.P.; Ketchen, D.W. (GA Technologies, Inc., San Diego, CA (USA)). 1983. Contract AT03-81SF11528. 9p. (CONF-830446—1). NTIS, PC A02/MF A01. Order Number DE83010809.

From American Power conference; Chicago, IL, USA (18 Apr 1983).

A monitored retrievable storage (MRS) facility is a long-term nuclear waste storage system. Monitoring ensures detection of waste package containment failures that could lead to release of radioactive materials. This protects facility personnel as well as the surrounding population and environment. Through basic design and monitoring of the stored material, easy retrievability is assured. This facilitates preparation of the stored material for later shipment to a reprocessing plant or repository. Monitored retrievable storage provides flexibility in the national nuclear waste management system. It can accommodate delays in the startup of the final re-

pository or store spent fuel until questions regarding reprocessing are resolved. It also offers the capability to age spent fuel and HLW to ease the thermal loading on the repository, or conversely, to increase the capacity of a given size repository. The size and handling rate required in an MRS facility are highly dependent on the fuel cycle scenario proposed.

29130 **(JAERI-M—9627) Development of partitioning method - cold and semihot experimental works with partitioning testing apparatus.** Kubota, M.; Yamaguchi, I.; Nakamura, H.; Tachimori, S.; Sato, A. (Japan Atomic Energy Research Inst., Tokyo). Aug 1981. 29p. (In Japanese). NTIS (US Sales Only), PC A03/MF A01. Order Number DE83701520.

The partitioning has been developed under the concepts of separating transuranium elements, ^{90}Sr and ^{137}Cs from a high-level fuel reprocessing waste, and then transmuting transuranium elements to fission products with fast neutron and fixing ^{90}Sr and ^{137}Cs as mineral like compound more stable than glass. The present paper describes the results of mainly 2 times semihot experimental works and of 2 times cold experimental works on the partitioning method consisting of solvent extraction and ion exchange by using the partitioning testing apparatus constructed in July of 1979. In these works a few troubles such as emulsification in the solvent extraction apparatus and foaming in the denitration vessel were evolved and solutions to these troubles could be found out individually. Even though there is a problem on designing an inorganic ion exchanger column for recovering ^{90}Sr and ^{137}Cs, transuranium elements which is the first objective in the partitioning could be separated in the yield over 99.9%. Complete provision of the cask for transporting a high-level liquid waste from PNC and performance tests for the partitioning testing apparatus will be continued and the partitioning method will be examined with 1 kCi of high-level liquid waste from PNC in the fiscal year of 1981.

29131 **(LA-UR—82-2282-Vol.1) Controlled air incinerator for radioactive waste. Volume I. Rationale, process, equipment, performance, and recommendations.** Neuls, A.S.; Draper, W.E.; Koenig, R.A.; Newmyer, J.M.; Warner, C.L. (Los Alamos National Lab., NM (USA)). Nov 1982. Contract W-7405-ENG-36. 43p. NTIS, PC A03/MF A01. Order Number DE83010767.

This two-volume report is a detailed design and operating documentation of the Los Alamos National Laboratory Controlled Air Incinerator (CAI) and is an aid to technology transfer to other Department of Energy contractor sites and the commercial sector. Volume I describes the CAI process, equipment, and performance, and it recommends modifications based on Los Alamos experience. It provides the necessary information for conceptual design and feasibility studies. Volume II provides descriptive engineering information such as drawings specifications, calculations, and costs. It aids duplication of the process at other facilities.

29132 **(LA-UR—82-2282-Vol.2) Controlled air incinerator for radioactive waste. Volume II. Engineering design references manual.** Koenig, R.A.; Draper, W.E.; Newmyer, J.M.; Warner, C.L. (Los Alamos National Lab., NM (USA)). Nov 1982. Contract W-7405-ENG-36. 141p. NTIS, PC A07/MF A01. Order Number DE83010766.

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This two-volume report is a detailed design and operating documentation of the Los Alamos National Laboratory Controlled Air Incinerator (CAI) and is an aid to technology transfer to other Department of Energy contractor sites and the commercial sector. Volume I describes the CAI process, equipment, and performance, and it recommends modifications based on Los Alamos experience. It provides the necessary information for conceptual design and feasibility studies. Volume II provides descriptive engineering information such as drawings, specifications, calculations, and costs. It aids duplication of the process at other facilities.

29133 **(NUREG—0960-Vol.1) Draft site characterization analysis of the site characterization report for the Basalt Waste Isolation Project, Hanford, Washington Site. Main report and Appendices A through D.** (Nuclear Regulatory Commission, Washington, DC (USA). Office of Nuclear Material Safety and Safeguards). Mar 1983. 420p. NTIS, PC A18/MF A01 - GPO. Order Number DE83901600.

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On November 12, 1982, the US Department of Energy submitted to the US Nuclear Regulatory Commission the Site Characterization Report for the Basalt Waste Isolation Project (DOE/RL 82-3). The Basalt Waste Isolation Project is located on DOE's Hanford Reservation in the State of Washington. NUREG-0960 contains the detailed analysis, by the NRC staff, of the site characterization report. Supporting technical material is contained in Appendices A through W.

29134 **(NUREG—0960-Vol.2) Draft site characterization analysis of the site characterization report for the Basalt Waste Isolation Project, Hanford, Washington site. Appendices E through W.** (Nuclear Regulatory Commission, Washington, DC (USA). Office of Nuclear Material Safety and Safeguards). Mar 1983. 429p. NTIS, PC A19/MF A01 - GPO. Order Number DE83901642.

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Volume 2 contains Appendices E through W: potential for large-scale pump tests in the Grande Ronde; review of hydrochemical characterization related to flow system interpretation in Hanford basalts; limitations of packer-testing for head evaluation in Hanford basalts; hydrogeologic data integration for conceptual groundwater flow models; drilling mud effects on hydrogeologic testing; site issue analyses related to the nature at the present groundwater system at the Hanford site, Washington; structural and stratigraphic characteristics related to groundwater flow at the Hanford site, Washington; seismic hazard and some examples of hazard studies at Hanford; earthquake swarms in the Columbia Plateau; seismic ground motion at depth; failure modes for the metallic waste package component; degradation mechanisms of borosilicate glass; transport and retardation of radionuclides in the waste package; determination and interpretation of redox conditions and changes in underground high-level repositories; determination and interpretation of sorption data applied to radionuclide migration in underground repositories; solubility of radionuclide compounds presented in the BWIP site characterization report; and release rate from engineered system.

29135 **(NUREG/CP—0028-Vol.3) Symposium on low-level waste disposal: facility design, construction, and operating practices.** Yalcintas, M.G. (comp.). (Oak Ridge National Lab., TN (USA)). Mar 1983. Contract W-7405-ENG-26. 448p. (CONF-820911—). NTIS, PC A19/MF A01 - GPO $11.00. Order Number DE83009128.

From Symposium on low level waste disposal; Washington, DC, USA (29 Sep 1982).

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This document is a compilation of the papers presented at the Low-Level Waste Symposium on Facility Design, Construction, and Operating Practices. Both proven practices, as well as innovative practices, were discussed as a means to supplement site characteristics. Individual papers were processed for inclusion in the Energy Data Base.

29136 (NUREG/CP—0028-Vol.3, pp 3-14) **Summary of the technical position paper on facility design and operation.** Pangburn, G.C. (Nuclear Regulatory Commission, Washington, DC). Mar 1983. NTIS, PC A19/MF A01 - GPO $11.00.

From Symposium on low level waste disposal; Washington, DC, USA (29 Sep 1982).

The NRC Technical Position Paper on Facility Design and Operations is to serve as an interpretation and expansion of the technical requirements in 10 CFR Part 61 for disposal site design and facility operation. These technical requirements are limited to near-surface disposal. The paper covers suggested practices for general site design, disposal unit design, surface water management, water management, waste handling and emplacement, and disposal

unit closure. A general goal dealt with in the paper is that of utilizing design methods of operation that avoid the need for continuing active maintenance. The paper also stresses that closure and stabilization are ongoing activities during site operation and not activities added at the end of operation.

29137 (NUREG/CP—0028-Vol.3, pp 27-37) **Lessons learned about disposal design.** Oztunali, O.I. (Dames and Moore, White Plains, NY). Mar 1983. NTIS, PC A19/MF A01 - GPO $11.00.

From Symposium on low level waste disposal; Washington, DC, USA (29 Sep 1982).

This paper presents a historical perspective on disposal facility design and its implementation (practices) in the US in view of the proposed 10 CFR Part 61 and the systems analysis approach recommended to achieve the performance objectives. Disposal facility design and practices are extremely important components of the systems approach to achieving the performance objectives since they can be controlled with a greater degree of confidence than some of the other components of the system. The predictability requirements of the proposed rule (i.e., the demonstration that the performance objectives are met) can most clearly be achieved if the license application relies heavily on components that can be controlled with confidence. An introduction amplifying the above concepts is presented first; this is followed by a recounting of several past disposal design related issues that influenced the formulation of 10 CFR Part 61 significantly. Lessons learned about disposal design and a discussion follow.

29138 (NUREG/CP—0028-Vol.3, pp 39-43) **Trench design and construction techniques for low-level radioactive waste disposal.** Tucker, P.G. (Army Engineer Waterways Experiment Station, Vicksburg, MS). Mar 1983. NTIS, PC A19/MF A01 - GPO $11.00.

From Symposium on low level waste disposal; Washington, DC, USA (29 Sep 1982).

Problems encountered with the disposal of low-level radioactive waste by shallow land burial have brought about the realization that a reevaluation of disposal trench design and construction techniques is needed. Subsidence, the bathtub effect, and the infiltration of groundwater into the disposal trench are among the problems that have cast doubts on the ability of some facilities to control the movement of their buried radionuclides. They have also made the goal of total passive maintenance unattainable in the near future. The Nuclear Regulatory Commission and the US Army Corps of Engineers, Waterways Experiment Station (WES) have entered into an agreement whereby the WES is preparing a document which will detail the critical parameters involved with the design and construction of low-level radioactive waste disposal trenches. These parameters will include those which should be controlled through the issuance of specifications or license restrictions in order to ensure that the facility will function as expected. This paper outlines the scope of the work, the work accomplished to date, the work remaining, and the basic philosophy behind the approaches taken in the preparation of this document.

29139 (NUREG/CP—0028-Vol.3, pp 45-65) **Conceptual facility designed for remedial action wastes.** Phelps, A.K. (Bechtel National, Inc., Oak Ridge, TN); White, M.G. Mar 1983. NTIS, PC A19/MF A01 - GPO $11.00.

From Symposium on low level waste disposal; Washington, DC, USA (29 Sep 1982).

Two conceptual designs are presented for below-grade land disposal in the Northeastern United States for remedial action wastes from the DOE Formerly Utilized Sites Remedial Action Program (FUSRAP). The wastes were generated by programs of the Manhattan Engineer District/Atomic Energy Commission (MED/AEC). These materials are largely trace-contaminated soils, sediments, and rubble resulting from a variety of activities, including research, processing, and storage of uranium and thorium ores and concentrates. The principal isotope of interest from a hazards control standpoint is ^{226}Ra. Conceptual designs are presented for disposal facilities for the states of New York and New Jersey. Each design is based on the estimated volume of FUSRAP waste in each state. Since no specific sites have been identified for the disposal facilities, the geologic, hydrologic, topographic, and meteorological conditions chosen for the conceptual design are representative of conditions in New York and New Jersey. The principal difference in the two sites is an assumed soil permeability factor which requires an engineered clay liner surrounding the waste for the New York facility, but not for the New Jersey facility. The conceptual designs are intended to be conservative and were developed to be compatible with 10 CFR 40, proposed 10 CFR 61, and proposed 40 CFR 192. The designs are developed in sufficient detail to verify the feasibility of the design concepts and to provide a basis for developing capital cost estimates for below-grade land disposal facilities.

29140 (NUREG/CP—0028-Vol.3, pp 73-91) **Surface water considerations in facility design and operation.** Schreiber, D.L. (Schreiber Consultants, Inc., Coeur d'Alene, ID). Mar 1983. NTIS, PC A19/MF A01 - GPO $11.00.

From Symposium on low level waste disposal; Washington, DC, USA (29 Sep 1982).

Surface water hydrology considerations are discussed for the design and operation of commercial low-level radioactive waste disposal facilities. Guidelines are recommended and bases presented for several hydrologic engineering factors, such as design flood flows, debris flows, erosion control, and water management, that must be accounted for in facility design and operation. Surface water hydrology practices at existing low-level radioactive waste disposal facilities are reviewed and compared with the recommended guidelines. Finally, the potential restrictiveness of the recommended guidelines is evaluated.

29141 (NUREG/CP—0028-Vol.3, pp 93-100) **Operational practices to facilitate closure of low-level waste disposal facilities.** DePoorter, G.L. (Los Alamos National Lab., NM). Mar 1983. NTIS, PC A19/MF A01 - GPO $11.00.

From Symposium on low level waste disposal; Washington, DC, USA (29 Sep 1982).

Final closure of a low-level waste disposal facility must be considered during most of the phases in the life cycle of the facility. This paper enumerates the reasons for considering the closure of a low-level waste disposal facility during the operational, closure, and postclosure observation phases in the life of the cycle of the facility. Actions required during the preoperational, operational, and closure phases that will facilitate closure are discussed by using example trench configurations for an arid site and for a humid site. Performance criteria for the closed site are discussed in terms of the information required to predict site performance and the operating practices necessary to ensure that this desired and predicted performance is obtained. Activities that must be considered include initial site characterization, site design and lay out, site construction, waste from acceptance criteria, waste handling and trench capping and suitable vegetation.

29142 (NUREG/CP—0028-Vol.3, pp 101-130) **Land disposal technique for hazardous and low-level radioactive waste containment and encapsulation of hazardous waste disposal sites.** Metry, A.A.; Corbin, M.H. (Roy F. Weston, Inc., West Chester, PA). Mar 1983. NTIS, PC A19/MF A01 - GPO $11.00.

From Symposium on low level waste disposal; Washington, DC, USA (29 Sep 1982).

This paper is based on several projects where hazardous waste and low-level radioactive waste was deposited on and below the surface. The primary objective of these projects was to develop stabilization and containment concepts for isolation of those waste materials and preventing potential migration of toxic and radioactive substances into the environment. Several concepts and control options are presented. These included: chemical fixation, grouting, bentonite slurry barrir, hydrogeologic isolation, impermeable covers and liners, ion exchange barrier, etc. A total containment concept includes the following: installation of clay liner for the purpose of waste containment, prevention of infiltration and alteration of radionuclide. A computer model was developed to determine the liner efficiency, alteration capacity and possible impact on groundwater quality.

29143 (NUREG/CP—0028-Vol.3, pp 161-175) **Light-water reactors low-level waste forms.** Guilbeault, B.D. (NUS Corp., Gaithersburg, MD). Mar 1983. NTIS, PC A19/MF A01 - GPO $11.00.

From Symposium on low level waste disposal; Washington, DC, USA (29 Sep 1982).

In the proposed 10 CFR Part 61, Licensing Requirements for Land Disposal of Radioactive Waste, three waste-classification groups for low-level waste are identified. This classification system is based on the radionuclide inventory. The category into which a waste falls determines the requirements for its disposal. With light-water reactor waste, the concentration of some radionuclides can be easily determined through routine analytical methods; however, some radionuclides are impractical to measure. Numerous past studies have characterized the physical waste form and have looked at the easily determined radionuclides. This paper will review the physical waste forms, outline where analytical information is currently available and/or easily obtainable, and discuss what further information on radionuclide concentrations is needed to meet the requirements of 10 CFR 61. The paper also discusses the possible changes in the waste form due to the increased emphasis of volume reduction and finally, several areas that will need to be addressed in the future. These areas are: ways that reactor operators can meet the analytical-characterization requirements for radionuclides in 10 CFR 61. Changes in disposal costs that may result from the adoption of 10 CFR 61. In its present form, 10 CFR 61 may influence the future light-water reactor waste form. The reactor-plant operator may find full-volume reduction and solidification a desirable alternative to segregation and a difficult if not impossible radionuclide characterization to dispose of Class A waste.

29144 (NUREG/CP—0028-Vol.3, pp 177-200) **12 years of experience of shallow land disposal of low and intermediate level radioactive waste in France.** Van Kote, F. (Commissariat a l'Energie Atomique, Paris, France). Mar 1983. NTIS, PC A19/MF A01 - GPO $11.00.

From Symposium on low level waste disposal; Washington, DC, USA (29 Sep 1982).

In France, the long-term industrial management of radioactive waste is handled by a national agency, the Agence Nationale pour la Gestion des Dechets Radioactifs (ANDRA) created in 1979 within the French Atomic Energy Commission. The French organization of radioactive waste management and ANDRA's work schedule and policy are briefly outlined. The solution adopted in France to dispose of low and intermediate activity level short-lived waste (LLW and ILW) is shallow land burial at the Centre de la Manche which has been set in operation in 1969. The safety basic principles and technical options adopted for shallow land are reviewed, then the different steps of waste management at the Centre de la Manche are described. Finally, the main conclusions drawn from the twelve years experience gained at the Centre de la Manche are detailed.

29145 (NUREG/CP—0028-Vol.3, pp 211-222) **NRC's perspective on acceptability and approval of new techniques.** Hawkins, E.F. (Nuclear Regulatory Commission, Washington, DC). Mar 1983. NTIS, PC A19/MF A01 - GPO $11.00.

From Symposium on low level waste disposal; Washington, DC, USA (29 Sep 1982).

In addition to the possibility that prospective licensees may propose a method other than near-surface disposal, the NRC anticipates that prospective licensees may propose near-surface disposal techniques considerably different from the cut-and-cover trench disposal previously used. In addition, the NRC recognizes that there are a variety of site-specific design features, operational procedures, and closure activities which may be employed to meet the technical requirements and satisfy the performance objectives in 10 CFR Part 61. Therefore, the NRC must be prepared to evaluate the range in methods for other than near-surface disposal and new techniques, design features, operational procedures, and closure activities for near-surface disposal. These will be reviewed on a case-by-case basis by the NRC staff and technical assistance contractors. It is important to emphasize that all other subparts of 10 CFR Part 61, most notably the performance objectives in Subpart C, remain the same regardless of the method of disposal or the technique of near-surface disposal. The prospective licensee must demonstrate that his combination of site characteristics, design, operations, waste form and institutional control will ensure that the performance objectives will be met. This applies whether for a near-surface disposal technology or an alternative. In order to do this, the applicant must describe the new method or near-surface disposal technique in sufficient detail and prepare an analysis leading to the conclusion that the performance objectives will be met. NRC must be able to independently reach the same conclusion. The applicant must support this description with a combination of techniques such as laboratory experiments, field-scale tests, full-scale field demonstrations, successful examples of similar applications (such as in hazardous waste disposal) and mathematical modeling.

29146 (NUREG/CP—0028-Vol.3, pp 223-252) **Overview of low-level radioactive waste disposal facilities subsidence.** Kahle, R.L.; Rowlands, J. (Ralph Stone and Co., Inc., Los Angeles, CA). Mar 1983. NTIS, PC A19/MF A01 -GPO $11.00.

From Symposium on low level waste disposal; Washington, DC, USA (29 Sep 1982).

The result of a case study of the Sheffield, Illinois, waste disposal facility, and literature reviews on problems at waste disposal facilities are presented. The types of problems, causes of the problems, and approaches to mitigate the problems are evaluated. The problems identified were surface subsidence, surface erosion, leachate and gas. Leachate resulted from water entry into trenches where subsidence occurred. Subsidence was attributed to random placement of waste containers into trenches leaving voids. The poorly compacted cover soil initially bridged the voids and subsequently collapsed and siphoned into the voids. Surface potholes and slumps resulted. Extensive potholding occurred during and after precipitation when the Sheffield loess soil piped into the voids. Long-term soil consolidation also resulted in area settlement. Potholes and slumps along the tops of walls between trenches constructed of fill were attributed to collapse of the walls into voids. Long-term subsidence was predicted as waste containers degraded and collapsed causing further slumps and potholes over a 50-year period. Excessive surface erosion resulted from poor vegetation cover and inadequacy of drainage controls. Approaches evaluated to stabilize disposal site trenches by compaction included dynamic consolidation, pile driving, surface surcharging, and surface compaction. Stabilization and leachate control by solidification with compaction grouting and chemical grouting were deemed effective but expensive. Accelerated degradation of the wastes by aerobic decomposition of organics and in-situ incineration were found to be less effective. Impervious trench caps were analyzed as a final moisture infiltration and leachate control method after stabilization was achieved. Recommendations for long-term trench maintenance were developed.

29147 (NUREG/CP—0028-Vol.3, pp 253-260) **Waste form and its role in trench stability.** Schweitzer, D.G. (Brookhaven National Lab., Upton, NY). Mar 1983. NTIS, PC A19/MF A01 - GPO $11.00.

From Symposium on low level waste disposal; Washington, DC, USA (29 Sep 1982).

NRC-supported programs evaluating past and present performance of shallow land burial sites and programs developing technical criteria for disposal of low-level waste in shallow land burial facilities provide convincing evidence of the importance of the waste form in providing trench stability. A summary is given of past problems in shallow land burial sites resulting from degradable waste and resultant trench subsidence. Programs supporting the technical justification for the proposed requirements on waste, waste forms and high integrity containers carried out at BNL indicate the requirements are necessary to assure safe isolation of low-level waste in shallow land burial sites.

29148 (NUREG/CP—0028-Vol.3, pp 261-267) **Waste emplacement and closure techniques.** White, L.A. (Golder Associates, Ellicott City, MD). Mar 1983. NTIS, PC A19/MF A01 - GPO $11.00.

From Symposium on low level waste disposal; Washington, DC, USA (29 Sep 1982).

Past practices in the disposal of low-level radioactive waste have been to randomly place waste packages into trenches to

within one meter of the ground surface. Typically, boxes and liners are stacked using forklifts and cranes and used as bulkheads to contain 55-gal drums which are randomly end dumped into the trenches. Earth materials excavated during trench construction are used to backfill the trenches to approximately original grade of the ground surface. The more clayey excavated soil is then used to construct a one-meter-thick cap on the trench, and this is covered with remaining natural overburden material which is graded and seeded to provide for drainage. The major factors that have determined past practices have been cost and the need to protect workmen from unacceptable radiation exposure. Experience has shown that such practices have led to expensive maintenance problems and difficulty in developing acceptable decommissioning schemes. In light of this experience one should weigh the front end capital costs associated with site development against likely costs for long-term maintenance and decommissioning. There are a number of waste emplacement and closure techniques that could reduce long term institutional commitments to maintain the integrity of the site. Practical and relatively inexpensive ways of bounding the problem of trench fill subsidence and subsequent problems of trench cap and site stability are proposed.

29149 (NUREG/CP—0028-Vol.3, pp 277-288) **Overview of design considerations for effective trench covers.** Skryness, R. (Stone & Webster Engineering Corp., Boston, MA). Mar 1983. NTIS, PC A19/MF A01 - GPO $11.00.

From Symposium on low level waste disposal; Washington, DC, USA (29 Sep 1982).

The siting, design, and operation of low-level radioactive waste disposal facilities are directed toward the isolation of waste. Isolation of waste from surface and ground water is the main concern for disposal sites, particularly those located in humid regions. For sites that satisfy the minimum technical requirements for siting, surface water control becomes the key factor in isolating buried waste. Trench covers are an integral part of the site's surface water control plan and function with other elements of disposal site to reduce surface water infiltration, and contribute to overall isolation of the buried waste. Attributes of a good cover design include constructibility, utilization of readily available materials, cost effectiveness, long-term reliability, and low maintenance. Thorough knowledge of the site's environmental, geological, and hydrological conditions, and familiarity with the proposed site layout, site development sequence, and disposal operations are important prerequisites for effective trench cover design. In the final analysis, trench cover performance depends on the successful implementation of the construction design and the cover's compatibility with trench geometry, site conditions, disposal operations, and the overall surface water control plan.

29150 (NUREG/CP—0028-Vol.3, pp 309-324) **Investigation of layered covers designed to limit infiltration at waste disposal sites.** Johnson, T.M.; Herzog, B.L.; Cartwright, K.; Larson, T.H. (Illinois Dept. of Energy and Natural Resources, Champaign). Mar 1983. NTIS, PC A19/MF A01 - GPO $11.00.

From Symposium on low level waste disposal; Washington, DC, USA (29 Sep 1982).

Layered soils of highly contrasting texture have been shown to act as a barrier to infiltration because of differences in unsaturated hydraulic properties. Water infiltrating into a fine-grained soil overlying an unsaturated gravel will not enter the gravel until the overlying material is nearly saturated. As a result of what is commonly called the wick effect, moisture will flow laterally through the fine-grained soil above the gravel layer. Layered covers of compacted soil materials utilizing this phenomenon have been proposed to limit infiltration at waste disposal sites. A study funded by the US Nuclear Regulatory Commission is underway to evaluate the potential use of layered trench covers to minimize infiltration at low-level radioactive waste disposal sites. Moisture movement through layered covers consisting of compacted fine-grained soils and sand or gravel was modeled, using a one-dimensional finite-difference model to compare with laboratory column experiments and a two-dimensional finite-element model for field-scale simulations. Soil-moisture characteristic data were obtained from laboratory experiments and the hydraulic conductivity was calculated as a function of capillary pressure. The numerical simulations indicate that layered covers using various combinations of compacted fine-grained soils and coarse-grained material are able to substantially reduce infiltration. Laboratory column experiments using a dual-gamma ray attenuation system to measure moisture content and density simultaneously have been used to observe the behavior of layered soils and to select materials for field testing. Currently underway are field-scale studies of alternative cover designs selected on the basis of two-dimensional modeling.

29151 (NUREG/CP—0028-Vol.3, pp 325-342) **Application of soil arch and soil beam concepts to the construction of shallow land burial trench covers.** Nowatzki, E.A.; McCray, J.G. (Univ. of Arizona, Tucson). Mar 1983. NTIS, PC A19/MF A01 - GPO $11.00.

From Symposium on low level waste disposal; Washington, DC, USA (29 Sep 1982).

Experience with shallow land burial sites indicates that undesirable surface subsidence and cracking of trench caps often occur a relatively short time after completion of backfilling. In the past, backfilling procedures have been rather arbitrary with the result that caps were often not strong enough to sustain themselves following creation of a void beneath them as the wastes decayed. In most cases, these cap failures may have been prevented by some form of soil stabilization at the time of construction. Three different trench cap designs were developed and prototype trenches were constructed in two different climatic environments to test the adequacy of the designs. The basic concept underlying each of the designs is that trench cap performance could be improved if the cap were stabilized in some way. In one design, controlled compaction alone was used to achieve high levels of in situ density. In another design, the emplacement of a strip of reinforcing geotextile in addition to controlled compaction was used. The third design incorporated a soil beam into the cap in addition to controlled compaction. A soil beam is a structural member constructed of compacted soil surrounded by an overlapping sheet of geotextile. Underlying each of these designs is the concept of a soil arch. Under proper conditions, soil has the ability to arch itself over small voids within the soil mass with little or no deformation at the surface. In order to test this concept and to evaluate the relative merits of the three designs, a system of settlement plates was installed at various levels in the caps. These settlement plates were monitored during and after construction so that absolute and relative displacements could be determined within a given trench. Differences in behavior among the three trenches could also be observed in this way. This paper describes the details of the designs and construction procedures.

29152 (NUREG/CP—0028-Vol.3, pp 347-364) **Alternatives to shallow land burial of low-level radioactive waste: an overview.** Ellis, J.L. (Gilbert/Commonwealth, Reading, PA). Mar 1983. NTIS, PC A19/MF A01 - GPO $11.00.

From Symposium on low level waste disposal; Washington, DC, USA (29 Sep 1982).

The alternatives to shallow land burial for disposal of low-level radioactive waste are identified and a brief description of each concept is provided. The alternatives can be categorized as follows: near term isolation concepts, far term isolation concepts, dispersion concepts, and conversion concepts. The more promising near term isolation concepts are discussed in terms of advantages and disadvantages, geological/environmental parameters, information/technology development requirements, and operational features.

29153 (NUREG/CP—0028-Vol.3, pp 365-377) **Intermediate-depth burial of low-level wastes.** Rogers, V.C.; Adam, J.A. (Rogers and Associates Engineering Corp., Salt Lake City, UT). Mar 1983. NTIS, PC A19/MF A01 - GPO $11.00.

From Symposium on low level waste disposal; Washington, DC, USA (29 Sep 1982).

Intermediate-depth burial is an alternative disposal method for those radioactive wastes that cannot be disposed in a traditional shallow land burial facility. In general, the environmental risks from surface intrusion events limit the radionuclide concentrations in wastes appropriate for near-surface disposal. The magnitude of these risks as well as the likelihood of a surface intrusion event are generally reduced as the depth of disposal increases. Therefore, many wastes exceeding Class C limits can be disposed safely at depths exceeding those for near-surface disposal, but which are sig-

nificantly less than depths for deep geologic disposal. However, in considering intermediate depth burial, care should be taken to avoid significant increases in risks from other pathways such as migration in groundwater. Examples of intermediate-depth burial are presented, along with cost comparisons to shallow land burial.

29154 (NUREG/CP—0028-Vol.3, pp 411-429) **Canadian experience with the storage and disposal of low- and intermediate-level wastes.** Feraday, M.A. (Chalk River Nuclear Labs., Ontario). Mar 1983. NTIS, PC A19/MF A01 - GPO $11.00.

From Symposium on low level waste disposal; Washington, DC, USA (29 Sep 1982).

In Canada, large quantities of low- and intermediate-level radioactive solid waste arise from nuclear power reactors and research sites, fuel and radioisotope production facilities and from many medical and industrial applications. Currently storage after volume reduction is being used as a safe way of managing these wastes for many years at a reasonable cost. Since permanent disposal has many advantages, disposal technologies including waste processing and characterization, site characterization, repository design and safety assessment are being developed. The preferred disposal strategy is one matching waste fractions, segregated according to hazardous life-time, with disposal concepts which can isolate wastes for the required period. Several possible disposal concepts are discussed.

29155 (NUREG/CR—3084) **Low-level nuclear waste shallow land burial trench isolation. Annual report, October 1981-October 1982.** McCray, J.G.; Nowatzki, E.A.; Thompson, G.M.; Betsill, D.J.; Mitwasi, R. (Arizona Univ., Tucson (USA). Coll. of Engineering). Mar 1983. 134p. NTIS, PC A07/MF A01 - GPO $6.00. Order Number DE83901639.

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The scope of this work covers an evaluation of trench cap designs, trench construction and trench loading by artificially speeding up the creation of void space in the trenches and monitoring structural and hydraulic effects under these conditions. Eight trenches were constructed and instrumented, four in a semi-arid region and four in a more humid mountainous region. The two main concepts being tested are the soil arch and the soil beam. Additionally, it is expected that methods will be developed for optimization of monitoring of sites as well as improved predictions of the relative long term stability of the tested designs. The results to date indicate that the soil beam and spoil arch are viable concepts that can be utilized in the design of shallow-land burial renches. The presence of geotextiles reinforcement does diminish the deleterious effects of moisture infiltration into the waste area. However, there are some contraints that may limit these applications to full scale, commercial operations. These constraints are: (a) need for moisture and soil match between trench sidewalls and backfill; (b) the maximum depth to width ratio of the backfill cap is dependent upon soil properties along the trench wall-cap interface; and (c) the soil beam should be sufficiently rigid not to slide off its end supports.

29156 (NUREG/CR—3091-Vol.1) **Review of waste package verification tests. Semiannual report, April-September 1982.** Bida, G.T.; Eastwood, D.; Jain, H.; Siskind, B.; Soo, P. (Brookhaven National Lab., Upton, NY (USA)). Apr 1983. Contract AC02-76CH00016. 145p. (BNL-NUREG—51630-Vol.1). NTIS, PC A07/MF A01 - GPO $6.00. Order Number DE83011205.

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The current study is part of an onging task to specify tests that may be used to verify that engineered waste package/repository systems comply with NRC radionuclide containment and controlled release performance objectives. Work covered to date describes tests for demonstrating that chemical and mechanical failure modes in TiCode-12 containers and bentonite- and zeolite-based packing materials do not compromise the approximately 1000-year containment period for these engineered barriers.

29157 (NUREG/CR—3206) **Unsaturated flow and transport through fractured rock - related to high-level waste repositories. Final report. Phase I.** Evans, D.D. (Arizona Univ., Tucson (USA). Dept. of Hydrology and Water Resources). Mar 1983. 242p. NTIS, PC A11/MF A01 - GPO $7.50. Order Number DE83901845.

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The principal objective of this study was to assess the state-of-the-art of characterizing unsaturated fractured rock geologic settings for possible high-level radioactive waste isolation. The primary approach has been to evaluate existing methods and computer models developed for unsatufated granular material and saturated fractured rock for application to unsaturated rock. The experimental methods explored relate to: (1) rock matrix characterization, (2) fracture characterization, (3) rock moisture status, and (4) water movement on a mesoscale. A model was developed to demonstrate the decrease in water conductance of fractures with decrease in water potential. Another model was developed to show vapor transport in the nonisothermal zone surrounding a repository, thus causing a drying and a wetting zone. For macroscale modeling of a repository setting, three fields are considered: (1) near-field, the zone surrounding the repository which is influenced by the heat generated by the radioactive waste, (2) meso-field, the unsaturated zone other than the near-field and to the regional water table, and (3) far-field, the zone beneath the regional water table. Clearly the nonisothermal unsaturated near-field is most complex and no existing model is available to realistically model this zone. Models are available for the meso-field and far-field but parameter estimation is a serious problem.

29158 (RFP—3249) **Rocky Flats Plant fluidized-bed incinerator.** Meile, L.J.; Meyer, F.G.; Johnson, A.J.; Ziegler, D.L. (Rockwell International Corp., Golden, CO (USA). Rocky Flats Plant). 8 Mar 1982. Contract AC04-76DP03533. 77p. NTIS, PC A05/MF A01. Order Number DE83010768.

Laboratory and pilot-scale testing of a fluidized-bed incineration process for radioactive wastes led to the installation of an 82-kg/hr demonstration unit at Rocky Flats Plant in 1978. Design philosophy and criteria were formulated to fulfill the needs and objectives of an improved radwaste-incineration system. Unique process concepts include low-temperature (550°C), flameless, fluidized-bed combustion and catalytic afterburning; in-situ neutralization of acid gases; and dry off-gas cleanup. Detailed descriptions of the process and equipment are presented along with a summary of the equipment and process performance during a 2-1/2 year operational-testing period. Equipment modifications made during the test period are described. Operating personnel requirements for solid-waste burning are shown to be greater than those required for liquid-waste incineration; differences are discussed. Process-utility and raw-materials consumption rates for full-capacity operation are presented and explained. Improvements in equipment and operating procedures are recommended for any future installations. Process flow diagrams, an area floor plan, a process-control-system schematic, and equipment sketches are included.

29159 (RFP—3372) **Rocky Flats Plant fluidized-bed incinerator. Engineering design and reference manual.** Meile, L.J. (Rockwell International Corp., Golden, CO (USA). Rocky Flats Plant). 5 Nov 1982. Contract AC04-76DP03533. 62p. NTIS, PC A04/MF A01. Order Number DE83010769.

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The information in this manual is being presented to complete the documentation of the fluidized-bed incineration (FBI) process development at the Rocky Flats Plant. The information pertains to the 82-kg/hour demonstration unit at the Rocky Flats Plant. This document continues the presentation of design reference material in the aeas of equipment drawings, space requirements, and unit costs. In addition, appendices contain an operating procedure and an operational safety analysis of the process. The cost figures presented are based on 1978 dollars and have not been converted to a current dollar value. Also, the cost of modifications are not included, since they would be insignificant if they were incorporated into a new installation.

29160 **(RFP—3471) Technology documentation for selected radwaste incineration systems.** Ziegler, D.L. (comp.). (Rockwell International Corp., Golden, CO (USA). Rocky Flats Plant). 1 Dec 1982. Contract AC04-76DP03533. 523p. NTIS, PC A22/MF A01. Order Number DE83010733.

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Several incineration systems have been developed and demonstrated on a production scale for combustion of radioactive waste from contractor operated Department of Energy (DOE) facilities. Demonstrated operating information and engineered design information is documented in this report on four of these systems; the Cyclone Incinerator (CI), Fluidized Bed Incinerator (FBI), Controlled-Air Incinerator (CAI) and Electric Controlled Air Incinerator (ECAI). The CI, FBI and CAI have been demonstrated with actual contaminated plant waste and the ECAI has been demonstrated with simulated waste using dysprosium oxide as a stand-in for plutonium oxide. The weight and volume reduction that can be obtained by each system processing typical solid plant transuranic (TRU) waste has been presented. Where a given system has been tested for other applications, such as combustion of resins, TBP-solvent mixtures, organic liquids, polychlorinated biphenyl (PCB), resuts of these experiments have been included. This document is a compilation of reports prepared by the operating contractor personnel responsible for development of each of the systems. In addition, as a part of the program management responsibility, the Transuranic Waste System Office (TWSO) has provided an overview of the contractor supplied information.

29161 **(RHO-BW-ST—38-P) Comparison of the hydrothermal stability of simulated spent fuel and borosilicate glass in a basaltic environment.** Apted, M.J.; Myers, J. (Rockwell International Corp., Richland, WA (USA). Rockwell Hanford Operations). Jul 1982. Contract AC06-77RL01030. 88p. NTIS, PC A02/MF A01. Order Number DE83010203.

Simulated spent fuel and borosilicate glass (PNL 76-68) were hydrothermally reacted with Umtanum basalt under test conditions simulating expected conditions for a nuclear waste repository located in basalt (NWRB) at the Hanford Site, Washington. Tests were performed in gold-bag sampling autoclaves at temperatures between 100°C and 300°C, 300 bars pressure, and a variety of mass ratios for the solids and groundwater. Systematic solution analyses included monitoring of pH, Eh, and dissolved concentrations of both matrix elements and potential radionuclides (as stable analog elements). All dissolved species displayed either steady-state concentration limits or decreasing concentration behavior after the first several hundred hours. Solids characterization suggests that formation of secondary alteration solids, such as alkali feldspar, smectite clays, scapolite, and a variety of uranium-rich silicate phases, impose solubility limits to the release of many potential radioactive elements. These steady-state (or solubility) concentration limits can be coupled with measured hydrologic flow rates to calculate meaningful radionuclide release rates from the waste form for a NWRB. It should be noted that comparison of waste forms from hydrothermal test results is limited by the chemical and structural disparity of the waste forms. Because of this disparity, each waste form will buffer the reacting system at different environmental conditions (e.g., pH, Eh) and, thus, the secondary solids that control radionuclide concentration levels will be necessarily different for each system. Emphasis on the stability of precipitated radionuclide-bearing solids (fate of radionuclides) is the preferred method of performance assessment.

29162 **(SAND—82-1069) Deformation of evaporites near the Waste Isolation Pilot Plant (WIPP) site.** Borns, D.J.; Barrows, L.J.; Powers, D.W.; Snyder, R.P. (Sandia National Labs., Albuquerque, NM (USA); Texas Univ., El Paso (USA). Dept. of Geological Sciences; Geological Survey, Denver, CO (USA)). Mar 1983. Contract AC04-76DP00789. 150p. NTIS, PC A07/MF A01. Order Number DE83011025.

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Layered evaporite units of Ochoan age in the Delaware Basin are 1000 m thick. They are divided into three stratigraphic units (listed in order of increasing age): the Rustler Formation, the Salado Formation, the Castile Formation. These units, especially the Castile, are deformed along portions of the margin of the Delaware Basin and in some areas internal to the basin. Hypotheses of origin of deformation considered are: gravity foundering; gravity sliding; gypsum dehydration; dissolution; and depositional variations. Gravity foundering and sliding are considered the most probable causes of deformation. However, no hypothesis adequately answers why the deformation has a limited areal distribution. A possible explanation would be areal variations in rock strength caused by variations of intergranular water content. Age and timing of deformation are also crucial. Standard stratigraphic arguments based on superposition may not apply to such a highly incompetent material as halite. Gravity foundering could have happened at any time since deposition including the present; gravity sliding would probably have occurred since basin tilting began in the Cenozoic. Deformation could be ongoing. However, the strain rates are such (10^{-16} s^{-1}) that deformation would progress slowly relative to the facility's time frame of 2.5 x 10^5 y. Deformation of Salado units would be minimal (<10 m) or nonexistent, but within this time frame, upper anhydrite units of the Castile could fracture and provide the volume for a brine reservoir. Such Volumes would be small (<1%) and would require 10^4 to 10^6 y to develop. At these strain rates, fractures that connect the fractured anhydrites of the Castile with the middle Salado could not develop. Deformation should not directly jeopardize the facility over the next 2.5 x 10^5 y.

29163 **(SAND—82-2478) Prediction of downhole waveforms.** Long, J.W.; Sabisch, K.A.; Stearns, S.D.; Vortman, L.J. (Sandia National Labs., Albuquerque, NM (USA)). Mar 1983. Contract AC04-76DP00789. 469p. NTIS, PC A20/MF A01. Order Number DE83010422.

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A least-squares linear prediction method using an optimum finite impulse response filter was used to predict a downhole velocity waveform. A filter was determined from surface and downhole velocity waveforms from several underground nuclear test events at each of several locations. Separate filters were determined for vertical, radial, and tangential components. Filters for each component for several events were averaged. Then the measured surface velocity waveform for a different event was used with the filter to predict the downhole velocity waveform for that event. Then the predicted or simulated downhole waveform was compared with the downhole velocity waveform measured on that event. The coherence between the measured and predicted velocity waveforms was evaluated using a normalized mean squared error. The method was applied to velocity waveforms generated by test events on Pahute Mesa and in Yucca Flat. Coherence was generally better for the vertical component than for radial and tangential components. Coherence was good for the surface/downhole pair at the station in the Climax granite pluton. It was especially poor for the pair in Rainier Mesa and for Dome Mountain and Fortymile Canyon (not a true surface/downhole pair) where topographic effects affected the horizontal components. The Climax granite pluton was found to rotate in a north-south direction regardless of whether the motion came from the south (Yucca Flat) or the west (Pahute Mesa). There is insufficient data to date from a recently installed surface/downhole pair in Yucca Mountain to apply the method as it was applied to other pairs. There is a similarity in geology of Yucca Mountain and Rainier Mesa. Therefore, the average filter from Rainier Mesa was applied to the surface velocity waveforms at Yucca Mountain from one event to predict the downhole waveform.

29164 **(SAND—83-0450) Summary evaluation of the Waste Isolation Pilot Plant (WIPP) site suitability.** Weart, W.D. (Sandia National Labs., Albuquerque, NM (USA)). Mar 1983. Contract AC04-76DP00789. 30p. NTIS, PC A03/MF A01. Order Number DE83010417.

Geotechnical studies oriented toward selecting a radioactive waste disposal site began in southeast New Mexico in 1972. These geological studies have focused on the present WIPP site since November 1975 and have been accompanied by investigations of the ecologic and socioeconomic environment. Surface-based geotechnical investigations have relied heavily on geologic mapping, on geophysical exploration techniques, and on drillholes for confirmation of interpretation, core examination, and acquisition of hydrologic parameters. These studies have now been supplemented by direct

examination and measurement of the subsurface geology in two shafts and in several thousand feet of mined drift at the depth selected for the WIPP. Additional studies are not likely to change significantly the level of confidence that now exists with regard to the suitability of the WIPP site. Consequently, Sandia has now evaluated the information available on the WIPP site and, in this report, summarizes the information and judgments reached for each of the 21 site qualification criteria. The site satisfies the intent of all the site criteria. Sandia recommends, without reservation, the use of the Los Medanos site for the WIPP.

29165 **(WIPP-DOE—154) Waste Isolation Pilot Plant. Project progress report, December 1, 1982-February 28, 1983.** (USDOE Albuquerque Operations Office, NM. Waste Isolation Pilot Plant Project Office). 1983. 16p. NTIS, PC A02/MF A01. Order Number DE83009949.

The Waste Isolation Pilot Plant (WIPP) is a defense activity of the Department of Energy. Its express purpose is to provide a research and development facility to demonstrate the safe disposal of radioactive waste resulting from the defense activities and programs of the United States exempted from regulation by the Nuclear Regulatory Commission. Site construction progress, design and engineering progress, technical and institutional activities and scientific and experimental studies are discussed briefly.

29166 **Method of preparing nuclear wastes for transportation and interim storage.** Bandyopadhyay, G.; Galvin, T.M. US Patent Application 6-383,880. 1 Jun 1982. 15p. Contract W-31-109-ENG-38.

Nuclear waste is formed into a substantially water-insoluble solid for temporary storage and transportation by mixing the calcined waste with at least 10 weight percent powdered anhydrous sodium silicate to form a mixture and subjecting the mixture to a high humidity environment for a period of time sufficient to form cementitious bonds by chemical reaction. The method is suitable for preparing an interim waste form from dried high-level radioactive wastes.

29167 **Alternate waste form evaluation for Savannah River Plant high-level waste.** Gould, T.H. Jr. (E. I. du Pont de Nemours & Company, Savannah River Laboratory, Aiken, SC 29808). *Transactions of the American Nuclear Society;* **41**: 276-277(Jun 1982). (CONF-820609—).

From American Nuclear Society annual meeting; Los Angeles, CA, USA (6 Jun 1982).

29168 **Borosilicate glass for immobilization of high-level SRP waste.** Kelley, J.A.; Papouchado, L.M. (E. I. du Pont de Nemours & Company, Savannah River Laboratory, Aiken, SC 29808). *Transactions of the American Nuclear Society;* **41**: 277-278(Jun 1982). (CONF-820609—).

From American Nuclear Society annual meeting; Los Angeles, CA, USA (6 Jun 1982).

29169 **Ground-penetrating radar in characterizing and monitoring waste burial sites.** Sandness, C.S.; Kimball, C.S. (Battelle-Pacific Northwest Laboratory, P.O. Box 999, Richland, WA 99352). *Transactions of the American Nuclear Society;* **41**: 71(Jun 1982). (CONF-820609—).

From American Nuclear Society annual meeting; Los Angeles, CA, USA (6 Jun 1982).

29170 **Low-level radwaste disposal in poisoned lands/inland seas.** Brookins, D.G.; Cohen, J.J.; Volger, H.A. Jr. (University of New Mexico, Albuquerque, NM 87131). *Transactions of the American Nuclear Society;* **41**: 75(Jun 1982). (CONF-820609—).

From American Nuclear Society annual meeting; Los Angeles, CA, USA (6 Jun 1982).

29171 **Radionuclide solubility and transport in basalt.** Jacobs, G.K. (Rockwell Hanford Operations, P.O. Box 800, Richland, WA 99352). *Transactions of the American Nuclear Society;* **41**: 282-283(Jun 1982). (CONF-820609—).

From American Nuclear Society annual meeting; Los Angeles, CA, USA (6 Jun 1982).

29172 **Precipitation-adsorption process for the decontamination of nuclear waste supernates.** Lee, L.M.; Kilpatrick, L.L. US Patent Application 6-379,800. 19 May 1982. 84p. Contract AC09-76SR00001.

High-level nuclear waste supernate is decontaminated of cesium by precipitation of the cesium and potassium with sodium tetraphenyl boron. Simultaneously, strontium-90 is removed from the waste supernate sorption of insoluble sodium titanate. The waste solution is then filtered to separate the solution decontaminated of cesium and strontium.

29173 **Phenolic cation-exchange resin material for recovery of cesium and strontium.** Ebra, M.A.; Wallace, R.M. US Patent Application 6-375,232. 5 May 1982. 29p. Contract AC09-76SR00001.

A phenolic cation exchange resin with a chelating group has been prepared by reacting resorcinol with iminodiacetic acid in the presence of formaldehyde at a molar ratio of about 1:1:6. The material is highly selective for the simultaneous recovery of both cesium and strontium from aqueous alkaline solutions, such as, aqueous alkaline nuclear wate solutions. The organic resins are condensation polymers of resorcinol and formaldehyde with attached chelating groups. The column performance of the resins compares favorably with that of commercially available resins for either cesium or strontium removal. By combining Cs^{+} and Sr^{2+} removal in the same bed, the resins allow significant reduction of the size and complexity of facilities for processing nuclear waste.

29174 **Sectioning techniques for plutonium-contaminated glove boxes.** Fetrow, L.K.; Allen, R.P.; McCoy, M.W. (Pacific Northwest Lab., Richland, WA). pp 109-114 of Proceedings of the ANS topical meeting on the treatment and handling of radioactive wastes. Columbus, OH; Battelle Press (1982).

From ANS topical meeting on treatment and handling of radioactive wastes; Richland, WA, USA (19 Apr 1982).

The size reduction of plutonium-contaminated glove boxes can substantially reduce storage and disposal volumes and is essential to prepare material for decontamination by advanced techniques such as vibratory finishing or electropolishing. Several industrial sectioning techniques have been evaluated at Pacific Northwest Laboratory under US Department of Energy sponsorship for the size reduction of plutonium-contaminated glove boxes. The techniques evaluated inlcude plasma arc torch cutting, mechanical sawing and nibbling, abrasive cutting, and hydraulic shearing and punching. These demonstration studies show that plutonium-contaminated glove boxes can be sectioned safely, efficiently, and with minimal secondary waste generation for size reduction or decontamination purposes using an appropriate combination of available industrial metal cutting techniques.

29175 **Vibratory finishing for decontamination: pilot scale operation.** McCoy, M.W.; Allen, R.P.; Fetrow, L.K.; Hazelton, R.F. (Pacific Northwest Lab., Richland, WA). pp 115-120 of Proceedings of the ANS topical meeting on the treatment and handling of radioactive wastes. Columbus, OH; Battelle Press (1982).

From ANS topical meeting on treatment and handling of radioactive wastes; Richland, WA, USA (19 Apr 1982).

This paper discusses the development of the vibratory finishing decontamination process from a laboratory demonstration to a pilot scale operation. Vibratory finishing is a standard industrial process used in a variety of manufacturing processes. Substantial progress has been made in adapting this vibratory finishing process to the needs of the nuclear industry, and especially to the management of TRU waste. The discussion includes a description of the vibratory finishing process; scale-up of the process inlcuding considerations of vibratory finisher size and configuration, rinsing and drying of the decontaminated material, materials handling, contamination control; and a cost analysis of the operation of a vibratory finishing decontamination system.

29176 **Radwaste incineration, is it ready for use.** Coplan, B.W. (BVC Consultants, Inc., Sun City Center, FL). pp 127-138 of Proceedings of the ANS topical meeting on the treatment and handling of radioactive wastes. Columbus, OH; Battelle Press (1982).

From ANS topical meeting on treatment and handling of radioactive wastes; Richland, WA, USA (19 Apr 1982).

The incinerator installed at JAERI in 1973 has the record of being operated continually for eight years without noticeable damage even in the refractories. We are convinced that it can be used for along period of time. These incinerators in Japan are now regarded as the useful and reliable waste management facilities, though they are processing the restricted sorts of wastes, such as low level ombustible solids and oils. In the future, incinerators of these types are supposed to increase in number in Japan, and they will continue to contribute as an important volume reduction measure which can also convert the wastes to chemically stable substances.

29177 **Volume reduction of radioactive resins through controlled incineration.** Brown, E.J.; Wu, J.M. (Rensselaer Polytechnic Inst., Troy, NY). pp 159-162 of Proceedings of the ANS topical meeting on the treatment and handling of radioactive wastes. Columbus, OH; Battelle Press (1982).

From ANS topical meeting on treatment and handling of radioactive wastes; Richland, WA, USA (19 Apr 1982).

Volume reduction experiments were carried out in a laboratory, scale prototype furnace under controlled incineration conditions. Nuclear grade cation-exchange resins from three manufacturers carrying simulated radioactive contamination were used in all experiments. Volume reductions were found to be approximately the same for each of the different resins. Reduction was found to be heavily dependent on the temperature of primary incineration and the presence or lack of oxygen. Volume reduction potentials of about 95% or better are achievable during oxidation incineration and 85% in pyrolysis carried out at 750°C. Entrainment levels of radioactive cesium in the offgas were measured for pyrolysis and oxidation incinerations carried out at 750°C and were found to be 0.54% and 1.7% respecitvely of the total cesium activity in the spent resin.

29178 **Controlled air pyrolysis incinerator.** Dufrane, K.H. (Atcor Engineered Systems, Inc., Farmington, CT); Wilke, M. pp 167-173 of Proceedings of the ANS topical meeting on the treatment and handling of radioactive wastes. Columbus, OH; Battelle Press (1982).

From ANS topical meeting on treatment and handling of radioactive wastes; Richland, WA, USA (19 Apr 1982).

An advanced controlled air pyrolysis incinerator has been researched, developed and placed into commercial operation for both radioactive and other combustible wastes. Engineering efforts cocentrated on providing an incinerator which emitted a clean, easily treatable off-gas and which produced a minimum amount of secondary waste. Feed material is continuously fed by gravity into the system's pyrolysis chamber without sorting, shredding, or other such pretreatment. Metal objects, liquids such as oil and gasoline, or solid products such as resins, blocks of plastic, tire, animal carcasses, or compacted trash may be included along with normal processed waste. The temperature of the waste is very gradually increased in a reduced oxygen atmosphere. Volatile pyrolysis gases are produced, tar-like substances are cracked and the resulting product, a relatively uniform, easily burnable material, is introduced into the combustion chamber. Steady burning is thus accomplished under easily controlled excess air conditions with the off-gasthen passing through a simple dry clean-up system. Gas temperatures are then reduced by air dilution before passing through final HEPA filters. Both commercial and nuclear installations have been operated with the most recent application being the central incinerator to service West Germany's nuclear reactors.

29179 **High-level waste vitrification technique in a full-scale pilot plant.** Weisenburger, S. (Karlsruhe Nuclear Research Centre, Germany). pp 190-196 of Proceedings of the ANS topical meeting on the treatment and handling of radioactive wastes. Columbus, OH; Battelle Press (1982).

From ANS topical meeting on treatment and handling of radioactive wastes; Richland, WA, USA (19 Apr 1982).

The liquid-fed ceramic melter process is reviewed and evaluated. Process application in a full-scale cold pilot plant, currently under construction in the Institute fuer Nukleare Entsorgungstechnik (INE), is described. It is concluded that the process has high potential for use in future industrial vitrification plants.

29180 **Utilization of a drum drier for the conditioning of radioactive wastes.** Halaszovich, S.; Dix, S.; Merz, E. (Inst. for Chemical Technology, Kernforschungsanlage, Juelich GmbH, Germany). pp 214-217 of Proceedings of the ANS topical meeting on the treatment and handling of radioactive wastes. Columbus, OH; Battelle Press (1982).

From ANS topical meeting on treatment and handling of radioactive wastes; Richland, WA, USA (19 Apr 1982).

Arguments are presented for the preference of a separate drying step in the solidification process of liquid wastes. In particular, the possibilities and advantages of the utilization of a drum drier for the conditioning of high- and medium-level wastes are described, referring to the experience gained in its conventional utilization underlined by practical use and experiments. Main aspects discussed are handling and safety, variety of possible products, throughput and economy. Finally, the future work is outlined.

29181 **Microstructures and crystallization in simulated waste glasses.** Skokan, A.; Schauer, V. (Kernforschungszentrum, Karlsruhe, Germany). pp 218-223 of Proceedings of the ANS topical meeting on the treatment and handling of radioactive wastes. Columbus, OH; Battelle Press (1982).

From ANS topical meeting on treatment and handling of radioactive wastes; Richland, WA, USA (19 Apr 1982).

A borosilicate glass has been developed as a solidification matrix for high level radioactive waste solution (HAW) at the Karlsruhe Nuclear Research Centre. As a part of product characterization, the microstructures and the crystallization behavior of the glass products were investigated in the range from 350 to 750°C with annealing times up to 10,000 hours. In addition to ruthenium oxide and palladium alloys that are insoluble in the melt, two major silicate phases were observed after thermal treatment. The maximum degree of crystallinity measured by x-ray diffraction analysis was between 20 and 30% at 650°C. Heat treatment below the transition temperature of the glass led to no appreciable crystallization.

29182 **IAEA's role in radioactive waste management, particularly for low- and intermediate-level wastes.** Irish, E.R. (International Atomic Energy Agency, Vienna, Austria). pp 227-233 of Proceedings of the ANS topical meeting on the treatment and handling of radioactive wastes. Columbus, OH; Battelle Press (1982).

From ANS topical meeting on treatment and handling of radioactive wastes; Richland, WA, USA (19 Apr 1982).

The management of low- and intermediate-level wastes is an area of increasing interest to practically all Member States having activities in the nuclear field, in particular to those which are producing electricity and heat by use of nuclear energy. This fact is reflected in the Agency's activities and in this presentation.

29183 **Low- and intermediate-level waste management practices in Belgium.** Claes, J.C.; Van de Voorde, N.; Dejonghe, P. (Study Centre for Nuclear Energy-CEN/SCK, Mol, Belgium). pp 234-242 of Proceedings of the ANS topical meeting on the treatment and handling of radioactive wastes. Columbus, OH; Battelle Press (1982).

From ANS topical meeting on treatment and handling of radioactive wastes; Richland, WA, USA (19 Apr 1982).

The main ongoing nuclear activities and the organization of LLW and ILW management in Belgium are descirbed. Data are presented on the waste arisings and characteristics. The treatment and ocnditioning techniques, currently applied at the waste processing plants, are reported. Attention is also drawn to the new processes and management improvements, which are being implemented and will become operational in 1982to 1983. The importance of sea dumping as a LLW disposal strategy for Belgium, among other West-European countries, is underlined. Information is given on the packaging procedures and sea dumping operations.

29184 **Low level and intermediate level wastes management practice in France.** Faussat, A. pp 243-248 of Proceedings of the ANS topical meeting on the treatment and handling of radioactive wastes. Columbus, OH; Battelle Press (1982).

From ANS topical meeting on treatment and handling of radioactive wastes; Richland, WA, USA (19 Apr 1982).

Having been directly in charge of waste disposal since 1979, ANDRA has already drawn some conclusions from the past experience obtained in shallow-land repositories. The regulations which exist in France for creating and operating a Basic Nuclear Installation provide a good framework for managing a shallow-land repository safely. Almost all short-lived wastes produced in the french nuclear program may be disposed of in shallow-land repositories and only alpha wastes and high level waste need a geological repository. Some special kinds of wastes might be better disposed of by sea dumping (tritium-bearing wastes, for instance) or in geological formations (high-level activated materials). Shallow-land repositories do not need a large surface of land enven if little dedicated to reducing volume. For instance, only 30 to 40 hectares are needed to dispose of the overall production of short-lived wastes in the year 2000. The use of shielded transportation casks instead of concrete integrated drums will reduce the volume of waste to be stored from the new electronuclear plants. The cost of disposal charged to ANDRA's customers is not very high. The average disposal costs for standardized package in 1981 were about: $300/m^3$ for wastes disposed in tumuli; $500/m^3$ for contact wastes disposed in normal concrete; and $1000/m^3$ for remote handled wastes disposed of in special trenches. Although all the technical aspects of shallow-land repositories are satisfactory, and while few problems arise with the population living around a repository already operational for a long time, some public opposition still remains to the creation of new disposal facilities - just as with any new nuclear installation. Basically, public option acceptance remains the only true bottleneck in the radwaste disposal.

29185 **LLW and ILW waste management practices in Italy.** Donato, A. (CNEN CSN-Casaccia, Rome, Italy). pp 249-253 of Proceedings of the ANS topical meeting on the treatment and handling of radioactive wastes. Columbus, OH; Battelle Press (1982).

From ANS topical meeting on treatment and handling of radioactive wastes; Richland, WA, USA (19 Apr 1982).

LLW and ILW radwastes are produced in Italy by power plants, pilot reprocessing plants and nuclear research centers. Liquid radwastes produced at old power plants are treated by ion exchange,chemical precipitation or evaporation, while in the new Caorso BWR plant Powdex resins and filtration and used, followed by urea-formaldehyde solidification. No solidification processes are used at two pilot reprocessing plants (Eurex and Itrec), while cementation and bituminization are employed at the research centers (Casaccia, Camen and Ispra). Solid wastes are generally compacted where possible and stored. The management of radwastes in Italy is highly influenced by the uncertainties concerning the type of disposal to be adopted.

29186 **Low- and intermediate-level waste management practices in Canada.** Charlesworth, D.H. (Atomic Energy of Canada Ltd., Chalk River, Ontario). pp 254-257 of Proceedings of the ANS topical meeting on the treatment and handling of radioactive wastes. Columbus, OH; Battelle Press (1982).

From ANS topical meeting on treatment and handling of radioactive wastes; Richland, WA, USA (19 Apr 1982).

Low- and intermediate-level wastes arise in Canada from the operation of nuclear power stations, nuclear research establishments, nuclear fuel and radioisotope production facilities, as well as from many medical, research and industrial organizations. Essentially all of the solid radioactive wastes are stored in a retrievable fashion at five waste management areas from which a portion is expected to be transferred to future disposal facilities. Waste processing for volume reduction and stabilization is becoming an increasingly important part of low-level waste management because of the advantages it provides for both interim storage currently, and permanent disposal in the future.

29187 **Low- and intermediate-level waste management practices in Japan.** Tsuchiya, M. (Radioactive Waste Management Center, Tokyo, Japan). pp 258-261 of Proceedings of the ANS topical meeting on the treatment and handling of radioactive wastes. Columbus, OH; Battelle Press (1982).

From ANS topical meeting on treatment and handling of radioactive wastes; Richland, WA, USA (19 Apr 1982).

At present, disposal of low-level radioactive wastes is yet to be carried out in Japan. Liquid wastes, except for the diluted discharge of very low-level waste into the environment, are mostly solidified with cement or bitumen to be packed in 200 litre drums and put in storage. Solid wastes, on the other hand, are mostly put into in 200 litre drums, some of them being incinerated beforehand. Efforts are being made to develop technology for reducing the production of wastes. Regarding sea disposal, a test dumping program has been forestalled by the opposition of South Pacific islanders, but we are endeavoring to promote their understandings on this matter. Regarding land disposal, first we are going to start centralized storage, then shift to underground disposal.

29188 **Low and intermediate level waste management practices in the United Kingdom.** Passant, F.H. (Central Electricity Generating Board, Gloucester, England). pp 262-266 of Proceedings of the ANS topical meeting on the treatment and handling of radioactive wastes. Columbus, OH; Battelle Press (1982).

From ANS topical meeting on treatment and handling of radioactive wastes; Richland, WA, USA (19 Apr 1982).

Current UK policy and practices for the management of low and intermediate activity wastes are summarized. Methods of treatment, packaging and transport are described for those wastes which are disposed of by shallow trench burial and by sea dumping. These disposal practices are described as are the methods of storage for those wastes awaiting disposal. Current and possible future developments are briefly outlined which include improved methods of handling and the establishment of disposal routes for all intermediate activity wastes.

29189 **US Department of Energy program for commercial low-level waste management: a progress report.** Brown, J.M. (EG and G Idaho, Inc., Idaho Falls, ID). pp 267-268 of Proceedings of the ANS topical meeting on the treatment and handling of radioactive wastes. Columbus, OH; Battelle Press (1982).

From ANS topical meeting on treatment and handling of radioactive wastes; Richland, WA, USA (19 Apr 1982).

The Low-Level Waste Management Program was established in September 1978 by the US Department of Energy. EG and G Idaho, Inc. in Idaho Falls, Idaho is the lead contractor for the National Program and has been coordinating program activities since 1979. The goal of the program is to ensure that low-level wastes are disposed of in a manner that will protect public health and safety over the long term. To accomplish this goal, the primary objective of the program is to provide an acceptable low-level waste management system by 1986. We are achieving this goal by working cooperatively with states, other government agencies, industry, public interest organizations, and the public. We are encouraging the involvement of these groups not only in assessing waste management problems, but in developing and implementing possible solutions. The program has involved representatives from broad interest areas in assessing policy, in developing recommendations, and in helping to formulate direction and emphasis for program activities. A two-year effort in developing national policy direction was completed in December 1981. The national strategy for low-level waste management outlines 17 policy recommendations that, once adopted, should lead to establishing an acceptable waste management system. Three major areas of program activity are focused on reaching this objective.

29190 **Coreless induction melting of simulated transuranic wastes.** McCall, J.L. (Battelle Columbus Labs., OH); Tenaglia, R.D.; Gibson, G.W.; Benedetti, R.L. pp 276-281 of Proceedings of the ANS topical meeting on the treatment and handling of radioactive wastes. Columbus, OH; Battelle Press (1982).

From ANS topical meeting on treatment and handling of radioactive wastes; Richland, WA, USA (19 Apr 1982).

The major objective of the Transuranic Waste Treatment Facility (TWTF) is to develop a facility to process low-level transuranic waste stored at the Idaho National Engineering Laboratory (INEL). One concept for processing the waste involves a first stage incineration process to reduce the level of combustibles and a second stage melting process to further consolidate the end product. Coreless induction melting was selected for evaluation as a melting process. Uncontaminated waste representative of the types of INEL wastes was charged directly onto the surface of a cast iron bath to form slag and metal products. Metal, slag, off-gas and particulate products were collected and characterized. Coreless induction melting was found to be a feasible method to process INEL waste provided that problems of low slag fluidity and short refractory life can be overcome.

29191 **Investigations of the treatment of alpha-contaminated wastes at the Karlsruhe Nuclear Research Center.** Krause, H. (Kernforschungszentrum, Karlsruhe GmbH, Germany). pp 282-286 of Proceedings of the ANS topical meeting on the treatment and handling of radioactive wastes. Columbus, OH; Battelle Press (1982).

From ANS topical meeting on treatment and handling of radioactive wastes; Richland, WA, USA (19 Apr 1982).

R and D-activities are being carried out with the aim of separating actinides and fission products from medium-level liquid wastes (MLLW) to such an extent that it virtually becomes a non-TRU waste and requires only a small shielding. Several types of TRU-waste concentrates have been encapsulated in a ceramic matrix successfully. this matrix is characterized by a low sensitivity to the chemical composition of the waste, a high leach resistance and radiation stability. Cladding hulls could be embedded in lead by pressing a mixture with lead chips at room temperature. The acid digestion process could be improved and developed to such an extent that active demonstration in a pilot plant can start in the near future.

29192 **Future trends in transuranic waste generation.** Jensen, R.T. (Rockwell International, Golden, CO). pp 287-291 of Proceedings of the ANS topical meeting on the treatment and handling of radioactive wastes. Columbus, OH; Battelle Press (1982).

From ANS topical meeting on treatment and handling of radioactive wastes; Richland, WA, USA (19 Apr 1982).

This paper presents data from the major Department of Energy (DOE) sites that will generate 92% of all Transuranic (TRU) waste during the next five years. Forecasts are given for three kinds of activities. They include producition, decontamination and decommissioning (D and D), and research and development. The major production activities and locations are described, and forecasts are given for each one. This report further describes the type and amount of waste forms that will be generated. The expected trends for the categories are presented. and possible areas for reducing waste generation are given.

29193 **Alpha content and long-term safety in nuclear waste management.** Hunt, B.A.; Dworschak, H.; Mousty, F. (Commission of the European Communities, Ispra, Italy). pp 306-310 of Proceedings of the ANS topical meeting on the treatment and handling of radioactive wastes. Columbus, OH; Battelle Press (1982).

From ANS topical meeting on treatment and handling of radioactive wastes; Richland, WA, USA (19 Apr 1982).

Radioactive waste management practices and concepts have been examined. The concentration/confinement concept always applicable to the HAW fraction has gradually and progressively been applied to the ever increasing MAW arisings containing significant long-lived components. Due to the long-term hazard posed by such components, mainly the transuranic actinides, particular efforts have been directed over the past few years to improvements in alpha waste reduction, conditioning and disposal. An alternative strategy however is proposed, backed by experimental results, which offers the possibility to combine all the alpha sources into a unique chemically homogeneous stream, thus allowing more stable matrices to be selected for their immobilization.

29194 **Department of Energy's selection of high level waste forms.** Walton, R.D. Jr. (Dept. of Energy, Washington, DC); Wilson, W.B.; Gordon, D.E. pp 313-317 of Proceedings of the ANS topical meeting on the treatment and handling of radioactive wastes. Columbus, OH; Battelle Press (1982).

From ANS topical meeting on treatment and handling of radioactive wastes; Richland, WA, USA (19 Apr 1982).

Several candidate waste forms have been investigated under US Department of Energy (DOE) programs as potential media for the immobilization and geologic disposal of high-level radioactive waste (HLW) resulting from chemical processing nuclear reactor fuels and targets. Two of these HLW forms were selected at the end of fiscal year (FY) 1981 for further development. Borosilicate glass was continued as the reference waste form and a crystalline ceramic material, Synroc, was selected as the alternative form. The selection of one of thes two forms for production in the Defense Waste Processing Facility (DWPF) at the Savannah River Plant site will be made before the end of FY 1983. This paper focuses on the selection of these two waste forms, including discussions on the historical perspectives of HLW treatment and disposal, the Materials Characterization organization, and the evaluation method used in the selection process.

29195 **Demonstration of SYNROC fabrication scaleup on a non-radioactive basis.** Ramm, E.J.; Reeve, K.D. (AAEC Research Establishment, Sutherland, Australia). pp 318-323 of Proceedings of the ANS topical meeting on the treatment and handling of radioactive wastes. Columbus, OH; Battelle Press (1982).

From ANS topical meeting on treatment and handling of radioactive wastes; Richland, WA, USA (19 Apr 1982).

SYNROC fabrication development at Lucas Heights is based on hot uniaxial pressing, and a method known as in-can hot pressing was devised for the first scaleup demonstration. The present in-can hot press consists of a 1-m-long induction furnace into which a 115-mm-diam stainless steel tube can be fitted and provided with lateral support, together with associated hydrauics. Five 30-kg canisters of dense SYNROC-B have been produced and the method is considered suitable for further development. Current plans for continuing SYNROC process development at Lucas Heights are outlined.

29196 **Leaching behavior of sintered modified SYNROC-B waste forms: effect of HLW addition.** Solomah, A.G. (North Carolina State Univ., Raleigh). pp 331-334 of Proceedings of the ANS topical meeting on the treatment and handling of radioactive wastes. Columbus, OH; Battelle Press (1982).

From ANS topical meeting on treatment and handling of radioactive wastes; Richland, WA, USA (19 Apr 1982).

Leachability studies for sintered Modified SYNROC-B waste forms containing up to 20 wt % simulated high-level radioactive waste have been investigated. Significant decreases in the leach rates of Ba, Ca, and Cs are noticed with the increase in waste loadings. The values of leach rates for Cs in deionized H_2O at 25° Care 0.007 and 0.001 $g\text{-}m^{-2}\text{-}d^{-1}$ al for 10 and 20 wt % simulated radioactive waste respectively. Barium and calcium showed similar leaching behavior. The results are presented and discussed.

29197 **Improved polyphase ceramic for high-level defense waste.** Harker, A.B.; Morgan, P.E.D.; Flintoff, J.; Clarke, D.R. (Rockwell International Science Center, Thousand Oaks, CA). pp 335-340 of Proceedings of the ANS topical meeting on the treatment and handling of radioactive wastes. Columbus, OH; Battelle Press (1982). Contract AT03-81SF11572.

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Modifications of the chemical formulation and processing of the Synroc-D polyphase ceramic for defense waste have been studied to provide greater flexibility with respect to compositional variations in the waste and to improve leach resistance. It has been demonstrated that by applying only that amount of reduction to the waste required to produce uranium in the 4+ state and by using lower consolidation temperatures, an improved ceramic can be

formed. The resulting ceramic consolidated at 1040°C and 10,000 psi maintanis the Synroc-D zirconolite, perovskite and nepheline phases; however, the two Synroc-D spinel phases are replaced with a single magnetite-type spinel and two additional radiophases, magnetoplumbite, and a cubic murataite-type phase. This modified phase assemblage provides crystalline ost sites for all radionuclides and trace elements in SRP waste, minmizes amorphoous intergranular material, and shows superior leach resistance.

29198 **High level waste forms: glass marbles and thermal spray coatings.** Treat, R.L.; Oma, K.H.; Slate, S.C. (Pacific Northwest Lab., Richland, WA). pp 341-345 of Proceedings of the ANS topical meeting on the treatment and handling of radioactive wastes. Columbus, OH; Battelle Press (1982).

From ANS topical meeting on treatment and handling of radioactive wastes; Richland, WA, USA (19 Apr 1982).

A process that converts high-level waste to glass marbles and then coats the marbles has been developed at Pacific Northwest Laboratory (PNL) under sponsorship of the US Department of Energy. The process consists of a joule-heated glass melter, a marble-making device based on a patent issued to Corning Glass Works, and a coating system that includes a plasma spray coater and a marble tumbler. The process was developed under the Alternative Waste Forms Program which strived to improve upon monolithic glass for immobilizing high-level wastes. Coated glass marbles were found to be more leach-resistant, and the marbles, before coating were found to be very homogeneous, highly impact resistant, and conductive to encapsulation in a metal matric for improved heat transfer and containment. Marbles are also ideally suited for quality assurance and recycling. However, the marble process is more complex, and marbles require a larger number of canisters for waste containment and have a higher surface area than do glass monoliths.

29199 **Evaluation of coated particle waste forms.** Gulden, T.D.; Erlandson, O.D.; Kaae, J.L.; Kovacs, W.J. (General Atomic Co., San Diego, CA). pp 346-350 of Proceedings of the ANS topical meeting on the treatment and handling of radioactive wastes. Columbus, OH; Battelle Press (1982).

From ANS topical meeting on treatment and handling of radioactive wastes; Richland, WA, USA (19 Apr 1982).

An in-depth evaluation of the technical merits and engineering practicality of coated particles, based on sol gel processes, as a candidate waste form has been performed. The results of the study showed that coated particle waste forms, because of the exceptional chemical inertness of the carbon and silicon carbide coatings, have the potentional for nearly absolute containment of radionuclides for geologic time peroids. The processes, although somewhat complex, are amenable to remote operation, and have considerable potential for further development and simplification. Coated particle fuels have inherent advantages for quality control sampling and are readily recycled for rework.

29200 **Factors to be taken into account in the selection and application of a processing system for TRU waste.** Krause, H. (Kernforschungszentrum, Karlsruhe GmbH, Germany). pp 353-356 of Proceedings of the ANS topical meeting on the treatment and handling of radioactive wastes. Columbus, OH; Battelle Press (1982).

From ANS topical meeting on treatment and handling of radioactive wastes; Richland, WA, USA (19 Apr 1982).

The greatest portion of presently arising TRU waste is either treated like other radwastes or stored intermediately. A large fast-breeder fuel cycle will call for a particular, self-contained TRU-waste treatment system. its main characteristics should be minimization of waste arisings, volume reduction, separation of plutonium and other actinides where reasonably achievable, recucling of plutonium, and incorporation of the TRU-waste concentrates into adequate matrix materials. Most of the processes and waste forms required are already available or under development.

29201 **State-of-the-art review on the management of low-level radioactive and transuranic wastes.** Godbee, H.W.; Kibbey, A.H. (Oak Ridge National Lab., TN). pp 357-361 of Proceedings of the ANS topical meeting on the treatment and handling of radioactive wastes. Columbus, OH; Battelle Press (1982).

From ANS topical meeting on treatment and handling of radioactive wastes; Richland, WA, USA (19 Apr 1982).

To place the management of low-level and transuranic wastes in perspective, the amounts of each waste type buried in 1980 and accumulated (with locations) through 1980 are presented. A review of the basic unit operations used to remove radioactivity from process and liquid waste streams shows that filtration, evaporation, and ion exchange remain the dominant ones. Centrifugation is frequently used to dewater filter sludges and spent resins. In the United States at present, dry wastes are, for the most part, compressed (compactor or baler) for burial. However, the present trend in waste management is toward greater volume reduction, improved waste form stability, and longer onsite storage (viz., at commercial sites). Thus, use of and interest in calcination, incineration, incorporation of wastes into stable matrices, and engineered onsite storage is growing.

29202 **Treatment of TRU wastes: recent results of developments underway in Germany.** Schneider, V.W.; Ledebrink, F.W. (ALKEM GmbH, Hanau, Germany). pp 362-366 of Proceedings of the ANS topical meeting on the treatment and handling of radioactive wastes. Columbus, OH; Battelle Press (1982).

From ANS topical meeting on treatment and handling of radioactive wastes; Richland, WA, USA (19 Apr 1982).

Objectives and projects of the German program on TRU waste treatment are briefly reviewed. Three tasks (Studies of TRU Waste Management, Development of Washing Processes, and An Improved Process for Solidification by Cement) are outlined in more detail. Recent results are communicated and the properties of the solidified products provided. Finally, a Scheme for Treatment of TRU waste from a MOX Fuel Fabrication Plant is presented.

29203 **Volume reduction and solidification of low radioactive and plutonium waste: technology and operation experience.** Hackstein, K.G. (NUKEM GmbH, Hanau, Germany). pp 375-378 of Proceedings of the ANS topical meeting on the treatment and handling of radioactive wastes. Columbus, OH; Battelle Press (1982).

From ANS topical meeting on treatment and handling of radioactive wastes; Richland, WA, USA (19 Apr 1982).

This presentation deals mainly with the volume reduction and solidification of radioactive waste generated from nuclear power plants, but also includes the work which has been done to reduce the volume of plutonium bearing waste generated by fuel-fabrication plants. I should mention that NUKEM GmbH has been active in the waste treatment field for many years. The technology and the operation experience described here are either based n our own work or on the activities of our partners. The increasing interest in volume reduction systems for radioactive waste either for volume reduction only or combined with solidification processes is mainly based on the necessity for minimizing or simplifying the handling, transportation and storage problem or on the demand for a conversion of these materials into a solid product which is suitable for a final storage. Cost calculations have also been made. At prima vista the advantage of volume reduction comes from reducing operation costs via less containers, reduced shipping costs and less burial charges. The calculations have been made in comparison to waste treatment costs without volume reduction. Such calculations are only valid underspecific assumptions depending on the different shipping, storage or burial regulations or conditions in each country and the utilities themselves have to calculate the minimum costs of waste treatment under their specific operation conditions. Since final regulations do not exist in nearly all countries realistic cost figures are hardly to define.

29204 **Recent advances in power plant radwaste volume reduction systems and end product characteristics.** Blewett, J.A. (Atcor Engineered Systems, Inc., Farmington, CT); Van Dorpe, M. pp 381-386 of Proceedings of the ANS topical meeting on the treatment and handling of radioactive wastes. Columbus, OH; Battelle Press (1982).

From ANS topical meeting on treatment and handling of radioactive wastes; Richland, WA, USA (19 Apr 1982).

The preconditioning of nuclear power plant liquid wastes is of vital importance if the volumes, decontamination factors (DF),

leachability and ability to solidify the wastes is to be optimized during the Volume Reduction Process. Extensive testing conducted by Belgonucleaire (BN) and ATCOR in the development of the ATCOR/BN Volume Reduction System has proven the benefits of the chemical pretreatment as a major part of the Volume Reduction Process for the following reasons: (1) The dried product behaves as a powdery material without the scaling and glassing characteristic of non-pretreated wastes, which allows for smoother operation of the process. (2) The solidified dried product exhibits improved leachability characteristics. (3) The DF's attainable in the evaporation process are improved by the pretreatment. (4) The volume of dried pretreated wastes are not significantly increased over the volume of dried non-pretreated wastes. The results of the equipment selection testing will be discussed identifying the characteristics of the equipment which were required to properly evaoprate, transfer and solidify the dried wastes. The equipment chosen and processing parameters which were selected for the TIHANGE 2 waste treatment and solidification system will be discussed. The factors of the design which enhance the operating performance, ability to decontaminate, simplicity of operation, maintainability and flexibility are detailed. TIHANGE 2 is scheduled to be operational in 1982 using the VR equipment descibed along with cement solidification for the boric acid based wastes. A conclusion disussing further system development envisioned and the economics of volume reduction is presented. A presentation of the various binders which have been tested in the process is included with comparisons of the loading ratios achievable with each type of waste.

29205 **Development of chemical methods of radioactive waste management for UK power reactor sites.** Bradbury, D. (Berkeley Nuclear Labs., England). pp 387-390 of Proceedings of the ANS topical meeting on the treatment and handling of radioactive wastes. Columbus, OH; Battelle Press (1982).

From ANS topical meeting on treatment and handling of radioactive wastes; Richland, WA, USA (19 Apr 1982).

Chemical processing can be beneficial in the management of medium level radioactive waste. The purpose of such processing is to reduce the volume of the waste, to separate active components from inactive components, or to change the waste;s chemical form to make it more amenable to safe disposal. This paper describes two chemical techniques which are currently being developed to assist in the management of radioactive waste from the UK's Magnox Power Reactor sites. The first case concerns regeneration and reuse of cesium-selective ion exchange materials and in the second case a process is described for selectively dissolving Magnox alloy waste in carbon dioxide saturated water as a means of separating it from active components.

29206 **Improved radwaste economics and operating performance by use of the etched disc backflushable filter.** Coplan, B.V. (BVC Consultants, Inc., Sun City Center, FL). pp 400-404 of Proceedings of the ANS topical meeting on the treatment and handling of radioactive wastes. Columbus, OH; Battelle Press (1982).

From ANS topical meeting on treatment and handling of radioactive wastes; Richland, WA, USA (19 Apr 1982).

A filter has been developed which eleminates, or greatly reduces, the problems and operating expenses encountered with cartridge and precoat filters. It has shown, in over 5 years of continuous online service, that it is both efficient and reliable and should be considered for any new or retrofit filtration application in radioactive liquid processing. Because of its rigid stainless elements, the Etched Disc Filter operates without the pressure and temperature limitations of the cartridge and precoat filters.

29207 **New aqueous waste treatment facility at Rocky Flats.** Peter, K.G. (Rockwell International, Golden, CO). pp 405-407 of Proceedings of the ANS topical meeting on the treatment and handling of radioactive wastes. Columbus, OH; Battelle Press (1982).

From ANS topical meeting on treatment and handling of radioactive wastes; Richland, WA, USA (19 Apr 1982).

The New Waste Treatment facility at Rocky Flats, Building 374, is designed to remove radioactive and chemical contaminants from aqueous process effluents collected from operations throughout the plant. By utilizing evaporation as well as precipitation, flocculation, and clarification, plant wastes are converted into reusable distilled water, disposable and retrievable solids, and exhaust gases. Total average capacity of the facility is 14,900 l/h as evaporator feed, producing an average of 80 kg/h of dried sludge and 320 kg/h of evaporator salts.

29208 **Remote aspects of treating and handling radioactive wastes.** Wegner, K. (NUKEM GmbH, Hanau, Germany). pp 423-427 of Proceedings of the ANS topical meeting on the treatment and handling of radioactive wastes. Columbus, OH; Battelle Press (1982).

From ANS topical meeting on treatment and handling of radioactive wastes; Richland, WA, USA (19 Apr 1982).

Carrying out detailed handling analysis on process components is the only way to get a fundamental basis for the choice of handling concepts. It is necessary to set up methods for the procedure of handling anlaysis in a systematic, uniform and checkable way. Large hot cell concepts promise a lot of advantages, but these concepts live and die with the availability of suitable handling equipment. High emphasis has to be put into the development of this special equipment.

29209 **Spray calcination of SRP waste compositions for ceramic waste forms.** Grantham, L.F.; Flintoff, J.F. (Rockwell International Corp., Canoga Park, CA). pp 445-448 of Proceedings of the ANS topical meeting on the treatment and handling of radioactive wastes. Columbus, OH; Battelle Press (1982).

From ANS topical meeting on treatment and handling of radioactive wastes; Richland, WA, USA (19 Apr 1982).

A heated-gas calciner produces a reactive powder suitable for ceramic immobilization of nuclear waste. This spray calciner has the added advantages of simultaneously destroying nitrates and organics in the waste. In addition, chemical tailoring as well as valence control were also accomplished during the calcination step. Though spray calcination remains the reference calcination method. Rockwell and LLNL are investigating alternate calcination methods for ceramic immobilization of nuclear waste.

29210 **High level waste management at the Idaho Chemical Processing Plant.** Berreth, J.R.; Dickey, B.R. (Exxon Nuclear Idaho Co., Idaho Falls, ID). pp 449-454 of Proceedings of the ANS topical meeting on the treatment and handling of radioactive wastes. Columbus, OH; Battelle Press (1982).

From ANS topical meeting on treatment and handling of radioactive wastes; Richland, WA, USA (19 Apr 1982).

This paper summarizes past and current high-level waste management practices at the Idaho Chemical Processing Plant (ICPP); options for long-term waste management of existing and future waste calcine are also emphasized.

29211 **New waste calcining facility at ICPP.** Smith, R.R.; Bingham, G.E.; Bench, F.D. (Exxon Nuclear Idaho Co., Idaho Falls, ID). pp 455-458 of Proceedings of the ANS topical meeting on the treatment and handling of radioactive wastes. Columbus, OH; Battelle Press (1982).

From ANS topical meeting on treatment and handling of radioactive wastes; Richland, WA, USA (19 Apr 1982).

A New Waste calcining Facility (NWCF) has been constructed at the Idaho Chemical Processing Plant (ICPP) to replace the Waste Calcining Facility (WCF) that was built to demonstrate fluidized-bed solidification of highly radioactive wastes. The NWCF is designed to provide capability for processing a variety of waste comositions at a higher throughput, more corrosion-resistant materials of construction, more effective cleanup of effluent streams, and extensive remote maintenance and equipment replacement capability. The NWCF also incorporates extensive decontamination capability in the event contact maintenance becomes necessary. Construction was completed in December 1980 and testing is approximately 95% complete, with completion in the spring of 1982. Hot operation is scheduled to begin in mid-year 1982.

29212 **High level waste management and characterization at the Hanford plant site.** Deichman, J.L. (Rockwell Hanford Operations, Richland, WA). pp 459-462 of Proceedings of the ANS topical meeting on the treatment and handling of radioactive wastes. Columbus, OH; Battelle Press (1982).

From ANS topical meeting on treatment and handling of radioactive wastes; Richland, WA, USA (19 Apr 1982).

Of the total 540-million curie fission product inventory at Hanford in 1981, 99% was generated as high-level waste. Methods of storing this inventory and methods for reducing the volume of this inventory are discussed.

29213 **10 CFR 61 waste form requirements.** Johnson, T.C.; Lohaus, P.H.; Smith, R.D. (Nuclear Regulatory Commission, Washington, DC). pp 465-466 of Proceedings of the ANS topical meeting on the treatment and handling of radioactive wastes. Columbus, OH; Battelle Press (1982).

From ANS topical meeting on treatment and handling of radioactive wastes; Richland, WA, USA (19 Apr 1982).

The Nuclear Regulatory Commission (NRC) staff is preparing a regulation on low-level radioactive waste management, 10 CFR 61. The performance objectives of this regulation stress: (1) the long-term stability of the disposal site to minimize water infiltration into trenches and to minimize remedial maintenance operations, and (2) the protection of individuals as well as populations. Based on these objectives, a waste classification system has been developed which is used for determining the waste form requirements for specific wastes.

29214 **Radioactive waste: commercial disposal practices.** Scoville, J.J. (US Ecology, Inc., Louisville, KY). pp 467-469 of Proceedings of the ANS topical meeting on the treatment and handling of radioactive wastes. Columbus, OH; Battelle Press (1982).

From ANS topical meeting on treatment and handling of radioactive wastes; Richland, WA, USA (19 Apr 1982).

Commercial low-level radioactive waste is disposed at three (3) commercial disposal facilities. These facilities differ from each other climatically as well as in hydrological and geological characteristics. Therefore, the individual sites must tailor the conduct of operations and the method of waste burial to provide for the proper long-term burial of low-level radioactive waste. This paper briefly examines the current disposal practices utilized at US Ecology's Beatty, Nevada and Richland, Washington disposal facilities.

29215 **Barnwell low-level waste disposal operations.** Ebenhack, D.G. (Chem-Nuclear Systems, Inc., Bellevue, WA). pp 470-471 of Proceedings of the ANS topical meeting on the treatment and handling of radioactive wastes. Columbus, OH; Battelle Press (1982).

From ANS topical meeting on treatment and handling of radioactive wastes; Richland, WA, USA (19 Apr 1982).

The primary issue that underlies all the regulatory and public scrutiny which has been evidenced for the last few years and will continue into the future, is one in which we in the nuclear industry, based upon a scientific and rational scheme, can show others that radioactive waste materials will be isolated from the biosphere until such time as the danger of environmental degradation is passed. The entire area has been marred by emotions and bias on both sides of the issue and only through a rational and informed decision-making process, as well as an education process for both the public and ourselves, will we work through this to a satisfactory end.

29216 **Alternatives for future land disposal of radioactive waste.** Mallory, C.W. (Hittman Nuclear and Development Corp., Columbia, MD). pp 472-475 of Proceedings of the ANS topical meeting on the treatment and handling of radioactive wastes. Columbus, OH; Battelle Press (1982).

From ANS topical meeting on treatment and handling of radioactive wastes; Richland, WA, USA (19 Apr 1982).

Shallow land burial incorporating improvements to facilitate stabilization and decommissioning will continue to be the primary method of disposing of low level waste in areas where conditions are suitable for this type of disposal. The existing disposal sites should be closely monitored to assure that continued acceptance of this method of disposal. Plans for the decommissioning of the existing sites should be closely reviewed to assure that the planning is adequate and that adequate resources will be available to implement the decommissioning plan. For these areas where geological conditions are not suitable for shallow land burial and in situations where a higher degree of containment is desired, alternative disposal methods should be considered. Technology exists or is readily attainable to provide engineered disposal facilities which provide a higher degree of containment and can be readily decommissioned. The cost of disposal using these methods can be competitive with shallow land burial when the cost of environmental and hydrogeologic investigations and decommissioning are included. Disposal of radioactive waste having low activity in secure sanitary landfills could significantly reduce the transportation and disposal requirements for low level waste.

29217 **Relations of equivalence of conditioned radioactive waste.** Kumer, L.; Szeless, A.; Oszuszky, F. (Oesterreichische Elektrizitaetswirtschafts AG, Vienna, Austria). pp 476-480 of Proceedings of the ANS topical meeting on the treatment and handling of radioactive wastes. Columbus, OH; Battelle Press (1982).

From ANS topical meeting on treatment and handling of radioactive wastes; Richland, WA, USA (19 Apr 1982).

A compensation for the wastes remaining with the operator of a waste management center, to be given by the agent having caused the waste, may be assured by effecting a financial valuation (equivalence) of wastes. Technically and logically, this equivalence between wastes (or specifically between different waste categories) and financial valuation has been established as reasonable. In this paper, the possibility of establishing such equivalences are developed, and their suitability for waste management concepts is quantitatively expressed.

29218 **Evaluation of geologic materials to limit biological intrusion of low-level waste site covers.** Hakonson, T.E.; White, G.C.; Karlen, E.M. (Los Alamos National Lab., NM). pp 491-496 of Proceedings of the ANS topical meeting on the treatment and handling of radioactive wastes. Columbus, OH; Battelle Press (1982).

From ANS topical meeting on treatment and handling of radioactive wastes; Richland, WA, USA (19 Apr 1982).

The long-term integrity of low-level waste shallow land burial sites is dependent on the interaction of physical, chemical, and biological factors that modify the waste containment system. This paper reports the preliminary results of a screening study to determine the effectiveness of four biobarrier materials to stop plant root and animal penetration into simulated low-level wastes. Experiments employed 288 lysimeters consisting of 25-cm-diam PVC pipe, with four factors tested: plant species (alfalfa, barley, and sweet clover); top soil thickness (30 and 60 cm); biobarrier material (crushed tuff, bentonite clay, cobble, and cobble-gravel); and biobarrier thickness (clay-15, 30, and 45 cm, others 30, 60, and 90 cm). The crushed tuff, a sandy backfill material, offers little resistance to root and animal intrusion through the cover profile, while bentonite clay, cobble, and cobble-gravel combinations do reduce plant root and animal intrusion thorugh cover profiles. However, dessication of the clay barrier by invading plant roots may limit the usefulness of this material as a moisture and/or biological barrier. The cobble-gravel combination appears to be the best candidate for further testing on a larger scale because the gravel helps impede the ingration of soil into the cobble layer - the probable cause of failure of cobble-only biobarriers.

29219 **In-situ stabilization of a low-level radioactive site: a case history.** Metry, A.A.; Phoenix, D.R. (Roy F. Weston, Inc., West Chester, PA). pp 497-504 of Proceedings of the ANS topical meeting on the treatment and handling of radioactive wastes. Columbus, OH; Battelle Press (1982).

From ANS topical meeting on treatment and handling of radioactive wastes; Richland, WA, USA (19 Apr 1982).

This paper is based on a feasibility study conducted by Roy F. Weston, Inc., for Sandia National Laboratory for the US Department of Energy's UMTRAP Project Office in Albuquerque, New Mexico. The US DOE is considering several methods for car-

rying out remedial actions in Canonsburg, Pennsylvania, at the site of an inactive uranium-processing mill. The main objective of this study is to determine the feasibility of in-situ stabilization as the remedial action. In-situ stabilization is an alternative to site decontamination and offsite disposal. The problems associated with offsite hauling of large quantities of contaminated material and with the location and development of a new disposal site could be avoided by the implementation of an in-situ stabilization concept. In addition, the in-situ approach would be more cost-effective than offsite disposal. This study will establish that a technically feasible and implementable in-situ stabilization concept can be developed that meets regulatory requirements and is cost-effective.

29220 **Scientific basis for nuclear waste management V.** Lutze, W. (ed.). New York, NY; North-Holland (1982). 910p. (CONF-820636—). Elsevier Science Publishing Co., Inc., 52 Vanderbilt Ave., New York, NY 10017.

From 5. international symposium on the scientific basis for radioactive waste management; Berlin, F.R. Germany (7 Jun 1982).

Ninety-one papers were presented in five sessions: properties of high-level radioactive waste forms; characterization of repositories; backfill materials and canister corrosion; migration of nuclides in the geosphere, and in-situ solidification of low- and medium-level radioactive waste. Research priorities for nuclear waste isolation are summarized. Eighty-five papers were indexed separately; six papers had already been indexed for the Energy Data Base.

29221 **Effects of waste composition and loading on the chemical durability of a borosilicate glass.** Clark, D.E.; Maurer, C.A.; Jurgensen, A.R.; Urwongse, L. (Univ. of Florida, Gainesville, FL). pp 1-13 of Scientific basis for nuclear waste management V. Lutze, W. (ed.). New York, NY; North-Holland (1982).

From 5. international symposium on the scientific basis for radioactive waste management; Berlin, F.R. Germany (7 Jun 1982).

The effects of waste composition and percent loading in a borosilicate glass designed for US defense high level wastes (HLW) have been evaluated. Three types of simulated wastes were investigated; high alumina, high iron and a composite representative of an average waste comp[osition from Savannah River Plant (SRP) waste tanks. Corrosion resistance of the borosilicate glass is significantly enhanced by the presence of any of the three types of wastes. Additionally, corrosion resistance is improved as the % waste loading is increased in the glass. The best corrosion performance was obtained with the high alumina waste in deionized water.

29222 **Mechanisms for hydrothermal leaching of nuclear waste glasses: properties and evaluation of surface layers.** Malow, G. (Hahn-Meitner-Institut fuer Kernforschung, Berlin, Germany). pp 25-36 of Scientific basis for nuclear waste management V. Lutze, W. (ed.). New York, NY; North-Holland (1982).

From 5. international symposium on the scientific basis for radioactive waste management; Berlin, F.R. Germany (7 Jun 1982).

The specific weight losses of the glass after leaching in rock salt and $MgCl_2$-$MgSO_4$-NaCl-KCl solutions were measured and surface layers were investigated. Leaching with various leachants leads to the formation of surface layers. Their composition and structures are complex. From the relative concentrations of the elements in the layers it must be assumed that the layers do not represent a partially leached glass phase and are formed by instantaneous precipitation of insoluble compounds, formed upon leaching. The drop in the leach rates suggests that the surface layer protects the long-term stability of the layers are the most important properties which must be known to understand the corrosion kinetics and leaching mechanisms of the glass. The mass release seems to be best fitted by the equation m/sub (t)/ = c . t/sup n/, but data are lacking for a precise calculation of the parameters n and c for all relevant conditions; n was found to be well below 0.5. Hence, congruent dissolution and diffusion controlled ion exchange, i.e., selective leaching, can be excluded as rate determining leaching mechanisms. Although the surface layers formed in the varous leachants are different in nature and composition, the protective property for the underlying glass can be assumed to be a common feature.

29223 **Stability and alteration of naturally occurring low-silica glasses: implications for the long term stability of waste form glasses.** Allen, C.C. (Univ. of New Mexico, Albuquerque). pp 37-44 of Scientific basis for nuclear waste management V. Lutze, W. (ed.). New York, NY; North-Holland (1982).

From 5. international symposium on the scientific basis for radioactive waste management; Berlin, F.R. Germany (7 Jun 1982).

Volcanic glass of basaltic composition (~ 50 wt % SiO_2) was studied as a natural analogue to proposed nuclear waste form glasses. Basaltic glass can resist devitrification and remain glassy for periods in excess of 10 m.y. Surface alteration of the glass occurs rapidly upon exposure to water or hydrothermal fluids, but is essentially absent if the glass remains dry. Alteration is restricted to a rind of clay-like, cryptocrystalline palagonite, generally less than 100 μm thick. Formation of this rind protects the underlying glass from further alteration. Similar rinds, or gel layers, have been produced in laboratory and field tests with borosilicate glasses. Major cations within the basaltic glass are selectively depleted or enriched relative to the glass in the alteration rind. Qualitatively-similar depletion and enrichment patterns charcterize the short-term leaching behavior of candidate waste form glasses.

29224 **Long-term radioactivity release from solidified high-level waste. Part I. An approach to evaluating experimental data.** Altenhein, F.K. (Hahn-Meitner-Institut fuer Kernforschung, Berlin, Germany); Lutze, W.; Ewing, R.C. pp 45-56 of Scientific basis for nuclear waste management V. Lutze, W. (ed.). New York, NY; North-Holland (1982).

From 5. international symposium on the scientific basis for radioactive waste management; Berlin, F.R. Germany (7 Jun 1982).

Safety and risk analyses for the isolation of radioactive waste in a repository must begin with a source term to quantify the amount of radioactivity released from the waste form under a specific set of conditions. The interaction of the waste form with aqueous solutions is the most important mechanism to consider, as any material released may be dissolved and reach the biosphere. In this regard the behavior of heat generating high-level waste is of particular importance, because reaction rates are higher at elevated temperatures. A long-term leach rate was derived from previous and continuing experimental work. The purpose of this paper is not to describe the real case release but rather to provide guidelines for the design of leaching experiments and determine the required precisiond for the data. This can be derived from the relative sensitivity of extrapolated leach rates for various parameters measured in laboratory experiments.

29225 **Flow model for the kinetics of dissolution of nuclear waste forms; a comparison of borosilicate glass, SYNROC and high-silica glass.** Macebo, P.B.; Barkatt, A.; Simmons, J.H. (Catholic Univ. of America, Washington, DC). pp 57-69 of Scientific basis for nuclear waste management V. Lutze, W. (ed.). New York, NY; North-Holland (1982).

From 5. international symposium on the scientific basis for radioactive waste management; Berlin, F.R. Germany (7 Jun 1982).

A model has been developed to predict the long-term leach or release rates of various waste-form materials under repository conditoins. The flow model has been applied to results of dynamic tests carried out over the range of flow rates between 0.5 to 300 m/yr at a temperature of 70°C on three glassy and two crystlline waste-form materials. These materials include Battelle PNL 76-68 borosilicate glass, Savannah River Laboratory TDS-131 borosilicate glass, CU PGM (Porous Glass Matrix) high-silica glass, Rockwell International polyphase ceramics (with nepheline as the major cesium host phase) supplied as representative of Tailored Ceramics, and Lawrence Livermore Laboratory Synroc-D. Quantitatively, the results indicate that the two borosilicate glasses, PNL 76-68 and SRL TDS-131, and the two ceramic waste-forms, Tailored Ceramics and Synroc-D, all exhibit approximately the same magnitudes of annual fractional loss (θ) over the entire range of flow rates. In the case of VU PGM (Porous Glass Matrix) high-silica glass, however, θ is lower by at least one order of magnitude, and at the higher flow rate region by two orders of magnitude, than the annual fractional low exhibited by all the other waste-forms. Most significantly, the results show that high-silica glass is the only material to fulfill the durability criterion required of high-level waste solids, i.e., a

long-term value of θ smaller than 1×10^{-5} (g/g . yr) under repository conditions. Reults obtained with other components show that the loss rates based on B and Na show less decline than those based on Si or Al as the flow rates decrease, but in all cases the loss rates measured for CU PGM glass are lower by 1 to 2 orders of magnitude than those obtained with the other waste-form materials under the same flow conditions.

29226 **Waste glass/repository interactions.** Clark, D.E.; Maurer, C.A. (Univ. of Florida, Gainesville). pp 71-82 of Scientific basis for nuclear waste management V. Lutze, W. (ed.). New York, NY; North-Holland (1982).

From 5. international symposium on the scientific basis for radioactive waste management; Berlin, F.R. Germany (7 Jun 1982).

The effects of repository material and a tailored backfill or overpack on the leaching behavior of glass have been studied. Two types of glasses were used in this investigation: (1) model glasses comprised of 33 mol % alkali oxide-67 mol % SiO_2, and (2) alkali borosilicate glasses with and without simulated wastes. Several types of repository material were placed in the same containers as the glasses to determine if their presence would alter the extent of leaching. A backfill material consisting of phosphate slime/sand mixtures was evaluated with the same procedure. The results indicate that the leaching behavior of the glass may be influenced by the presence of some materials. Preliminary results of a 16 1/2 month burial experiment in Florida are also discussed.

29227 **Leaching of vitrified high-level radioactive waste.** Hall, A.R.; Hough, A.; Marples, J.A.C. (AERE Harwell, England). pp 83-92 of Scientific basis for nuclear waste management V. Lutze, W. (ed.). New York, NY; North-Holland (1982).

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The work reported here is part of a study of the leaching of individual elements from waste glasses. The first part of the paper reports on leaching of the major constituents at 30°C, and leaching of the alkalis at 20°C from glass UK189; the second part describes leaching of Sr, Cs, Tc and various actinides from glasses UK189 and UK209.

29228 **Relationship between glass leaching mechanism and geochemical transport of radionuclides.** Avogadro, A.; Lanza, F. (Commission of the European Communities, Ispra, Italy). pp 103-112 of Scientific basis for nuclear waste management V. Lutze, W. (ed.). New York, NY; North-Holland (1982).

From 5. international symposium on the scientific basis for radioactive waste management; Berlin, F.R. Germany (7 Jun 1982).

In this paper an attempt has been made to subdivide the different elements present in the vitrified waste into classes in order to simplify the description of the release of the radioelements in the various repository conditions. From the discussion of the different classes it appears clearly that the evaluation of the release of the different radionuclides depends strongly on the transport in the geological medium. In addition, to evaluate the transport it is necessary to know the physico-chemical species under which the various nuclides are leached. Consequently, there is a strong relationship between transport and leaching; any separation of the two phenomena risks being artificial.

29229 **Leaching of actinides from simulated nuclear waste glass.** Pickering, S. (Commission of the European Communities, Karlsruhe, Germany); Walker, C.T.; Offermann, P. pp 113-124 of Scientific basis for nuclear waste management V. Lutze, W. (ed.). New York, NY; North-Holland (1982).

From 5. international symposium on the scientific basis for radioactive waste management; Berlin, F.R. Germany (7 Jun 1982).

Two types of simulated nuclear waste glass doped with actinides were leached at 200°C in distilled water and salt solutions. Am, Np, Pu and U were all preferentially retained in the surface layer on the glass. Leaching ratios of 0.1 to 0.2 for Np and ~ 0.02 for Am were measured. The losses of Am and Np to the leachant were proportional to the total weight loss of the glass and were larger at 10 ml leachant/cm^2 glass than at 5 ml/cm^2. Weight loss from the glass occurred only at the start of the experiments for periods ranging from 10 h to 10 days according to leachant composition and volume. Wt losses from the C31-3-EC glass were much greater in saturated NaCl solution than in distilled water. Enrichment in the outer surface layer of Al or Ca according to glass type could be correlated with leachant pH, glass composition and weight loss measurements.

29230 **Influence of a backfilling material on borosilicate glass leaching.** Lanza, F.; Ronsecco, C. (Commission of the European Communities, Ispra, Italy). pp 125-133 of Scientific basis for nuclear waste management V. Lutze, W. (ed.). New York, NY; North-Holland (1982).

From 5. international symposium on the scientific basis for radioactive waste management; Berlin, F.R. Germany (7 Jun 1982).

The results of the leaching tests in different types of paste have shown that the presence of an absorbing medium around the glass tends to eliminate the saturation conditions that are present in water or water solution. It is conceivable that such an effect is transitory. When the clay surrounding the glass is saturated, the composition of the leachate will begin to evolve toward saturation and will probably be diffusion-controlled. However, at least for the first period, a model is dissolution in large amounts of water fits the experimental data better than a model based on satural effects. Tests performed with addition of Fe_2O_3 show that the influence of corrosion products is not negligible. Their presence partially saturates the absorptive center of the clay, altering the leaching conditions. The use of Fe_2O_3 to simulate corrosion products is probably a crude approximation. A more realistic approach is needed. If a similarity exists between leaching data tests in paste and in large amounts of water, the surface composition in the two cases is largely different. In the first case, in the external part of the film, silicon precominates while in the second case iron is prevalent. At 80°C the surface composition does not seem to affect the capacity of the surface layer of reducing the leaching rate with time. At 50°C tests with the highest iron content present lower values of weight losses.

29231 **Effect of overpack materials on glass leaching in geological burial.** Werme, L. (KBS, Stockholm, Sweden); Hench, L.L.; Lodding, A. pp 135-144 of Scientific basis for nuclear waste management V. Lutze, W. (ed.). New York, NY; North-Holland (1982).

From 5. international symposium on the scientific basis for radioactive waste management; Berlin, F.R. Germany (7 Jun 1982).

The metallic overpacks (Pb, Cu, Ti) have little effect on the corrosion of borosilicate nuclear waste glasses under either 90°C or 8°C burial conditions in deep granite. Corrosion layers for metal-glass-interfaces are generally thinner than for glass-glass intrefaces. One possible reason for this is that the ductile metallic materials allow only a very thin water film between the glass and the metal. This thin water film becomes rapidly saturated with corrosion products and further corrosion in consequently slower.

29232 **Interaction of borosilicate glass and granodiorite at 100°C, 50 MPa: implications for models of radionuclide release.** Savage, D.; Robbins, J.E. (Harwell Lab., Oxfordshire, England). pp 145-152 of Scientific basis for nuclear waste management V. Lutze, W. (ed.). New York, NY; North-Holland (1982).

From 5. international symposium on the scientific basis for radioactive waste management; Berlin, F.R. Germany (7 Jun 1982).

The interaction of a simulated borosilicate waste glass, granodiorite and deionized water at 100°C, 50 MPa under closed system experimental conditions has revealed the rapid achievement of steady-state fluid concentrations for many chemical components of interest, (e.g., SiO_2, La) and their rates of release from the near-field would be most appropriately modelled by a function of solubility and groundwater flow-rate. The conversion of these solubilities into conventional leach-rates has shown over five orders of magnitude range in relative release rates and emphasizes the need for source-term models to consider each radionuclide separately in terms of mechanisms of release.

29233 **Burial effects on nuclear waste glass.** Hench, L.L. (Univ. of Florida, Gainesville); Werme, L.; Lodding, A. pp 153-162 of Scientific basis for nuclear waste management V. Lutze, W. (ed.). New York, NY; North-Holland (1982).

From 5. international symposium on the scientific basis for radioactive waste management; Berlin, F.R. Germany (7 Jun 1982).

The purpose of this experiment was to evaluate the effects of various components of the SKBF/KBS nuclear waste storage system on the leaching of the vitreous waste form. Two configurations of nuclear waste glasses, canisters, overpacks, and backfill material were inserted into 5.6 cm x 3 m deep boreholes located at the 350 m level in the Stripa mine. Some were maintained at 90°C. The others were allowed to equilibrate at the ambient temperature of the mine, about 8°C. Two borosilicate nuclear waste glass compositions (ABS 39 and ABS 41) compatible with the French AVM process containing 9% by weight of simulated fission products were compared. The two compositions bracket the range of $SiO_2/Na_2O/B_2O_3$ ratios likely to be selected for commercial vitrification operations at La Hague. there are only minor differences in the ion depletion levels at surfaces of glass ABS 39 and 41 during 28 days and 3 mo., 90 or 8°C burial in Stripa at 350 m. In-depth compositional profiles show growth rates of layers with selective depletion of Na, B, at up to ca. 1.5×10^{-7} m/day for glass 39 and up to ca. 2.5×10^{-8} m/day for glass ABS 41. A thin film rich in Si, Fe, and Al forms on both glasses during burial. Moist or wet bentonite accelerates the rate of ion depletion for both glasses, with glass ABS 39 the worst, in both laboratory and Stripa burial experiments. The bentonite effect is much less in burial environments than in lab simulations. There is little difference in burial surface reactions between pineapple slice configurations and minicans.

29234 Chemical durability of some HLW glasses: effects of hydrothermal conditions and ionizing radiation. Cousens, D.R.; Lewis, R.A.; Myhra, S.; Segall, R.L.; Smart, R.S.C.; Turner, P.S. (Griffith Univ., Queesland, Australia). pp 163-171 of Scientific basis for nuclear waste management V. Lutze, W. (ed.). New York, NY; North-Holland (1982).

From 5. international symposium on the scientific basis for radioactive waste management; Berlin, F.R. Germany (7 Jun 1982).

The time dependence of leaching and dissolution under hydrothermal conditions at 250°C has been investigated in an autoclave designed for continuous sampling; it is found that the rates are in accord with those obtained by the commonly used procedures. The effect of pressure by itself has been studied in an ultracentrifuge; ambient rates for Si and Na loss remain unchanged up to about 40 MPa followed by a monotonic increase to about 1.5 times the ambient rates at 160 MPa. The surface layers formed as a result of chemical attack have been examined (XRD, IR, XPS and PIXE). It is found that Zn present in the glass or in the solution is retained in the siliceous layer which in some circumstances contains a crystalline zinc-hydroxy-silicate phase. A method for enhancing rates of displacement damage by a factor of $\sim 10^6$ has been developed. Powdered borosilicate glass and glass doped with UO_2 have been neutron-irradiated in a high-flux reactor. Damage is thereby introduced in the bulk as a result of $^{10}B(n, \alpha)^7Li$ and (n,fission) events and subsequent slowing-down of energetic charged ions. Irradiation doses equivalent to 10^6 years HLW storage have been achieved. The resultant stored energy of $\sim 10^3$ kJ kg^{-1} is released over the range 300 to 800 K. The initial leaching/dissolution rates are found to be increased by a factor of about three by irradiation; the changes in longer-term rates are difficult to determine due to the effects of back-reactions and changing particle size geometry and size distribution, but significant enhancement is found. Rates for fission and activation products are similar to those for bulk species.

29235 Determination of the corrosion mechanisms of high-level waste containing glass. Scholze, H.; Conradt, R.; Engelke, H.; Roggendorf, H. (Fraunhofer-Institut fuer Silicatforschung, Wuerzburg, Germany). pp 173-180 of Scientific basis for nuclear waste management V. Lutze, W. (ed.). New York, NY; North-Holland (1982).

From 5. international symposium on the scientific basis for radioactive waste management; Berlin, F.R. Germany (7 Jun 1982).

The observations and investigations of the corrosion behavior of two rather different model waste glasses in salt brines revealed the simultaneous action of several corrosion mechanisms. The differences between the two glasses refer to different extents of the same mechanisms. The glass matrix itself is involved in matrix dissolution (disintegration) and corrosion profile formation processes. The latter comprise silicon enrichment and alkali and alkaline earth depletion. A comparison between the matrix dissolution depths and the profile depths shows that the matrix is submitted to an almost congruent dissolution. Nevertheless the overall time law has an exponent between 0.5 and 1. Taking into account the results by G. Malow one may assume that the reaction layers which are formed on the glass surfaces during corrosion enforce the time law. This assumption has to be modified by the fact that the profiles in the rest glass pass through a temporal development, too. I.e., the conditions for the reaction layer formation are continuously changed because of the surface concentration change of the underlying rest glass. The meaning of either processes for a long term behavior of waste glass till needs clarification.

29236 Leaching behavior of a simple borosilicate glass in a confined environment. Petit, J.C.; Langevin, Y.; Lameille, J.M.; Dran, J.C. pp 203-210 of Scientific basis for nuclear waste management V. Lutze, W. (ed.). New York, NY; North-Holland (1982).

From 5. international symposium on the scientific basis for radioactive waste management; Berlin, F.R. Germany (7 Jun 1982).

Centimeter-sized blocks of a simple borosilicate glass have been leached in hydrothermal conditions with various rates of water renewal. Weight loss measurements reveal that restricted water access does not slow down the dissolution rate of this particular glass as would be expected from solubility limits, but instead accelerates its destruction and its transformation into secondary solid phase still ill-defined.

29237 Comparative study of seven glasses for solidification of nuclear wastes. Nogues, J.L. (Universite des Sciences et Techniques du Languedoc, Cedex, France); Hench, L.L.; Zarzycki, J. pp 211-218 of Scientific basis for nuclear waste management V. Lutze, W. (ed.). New York, NY; North-Holland (1982).

From 5. international symposium on the scientific basis for radioactive waste management; Berlin, F.R. Germany (7 Jun 1982).

The relative leaching behavior of seven alkali borosilicate glasses considered for immobilization of high-level radioactive wastes was compared using a static 90°C leach test similar to MCC-1. With the range of glass compositions studied, it was not possible to determine the effect of each element on leaching behavior, however some conclusions regarding the general influence of the glass network formers can be made: (1) The addition of Al_2O_3, between 2 and 5% (weight) results in a large increase in the chemical durability of the glass. (2) The presence of Fe_2O_3, between 1.5 and 3% (weight) is necessary to develop with Al_2O_3 a second protective layer on top of the silica-rich film that results from rapid dealkalization. (3) To obtain good durability the glass composition must contain more than 51% (weight) of ($SiO_2 + Al_2O_3$) and more than 54% (weight) of ($SiO_2 + Al_2O_3 + Fe_2O_3$). (4) The best result was obtained with glass M3 which contans 55.18% (weight) of ($SiO_2 + Al_2O_3$) and 56.78% (weight) of ($SiO_2 + Al_2O_3 + Fe_2O_3$). High leach resistance and good surface stability was present event though this glass contained the largest quantity of Na_2O (13.19%) in the series. (5) the difference between the results obtained at Sa/V = 1.0 cm^{-1} and SA/V = 0.1 cm^{-1} shows the importance of understanding both the effects of glass composition and solution concentrations on the behavior of nuclear waste glasses.

29238 Chemical stability of simulated HLW forms in contact with clay media. Van Iseghem, P.; Timmermans, W.; De Batist, R. (SCK/CEN, Mol, Belgium). pp 219-227 of Scientific basis for nuclear waste management V. Lutze, W. (ed.). New York, NY; North-Holland (1982).

From 5. international symposium on the scientific basis for radioactive waste management; Berlin, F.R. Germany (7 Jun 1982).

The corrosion stability of six simulated HLW forms proposed by several European countries (five borosilicate glasses and one borosilicate glass ceramic) in contact with different media relating to the clay disposal has been investigated for periods up to 80 days and at a surface area to solution volume ratio of 1 cm^{-1} under non de-aerated conditions. In the reference medium distilled water the corrosion stabilities are largely determined by saturation effects for elements such as Si, Ca, Mg, Sr, Fe and U. Si saturation is found to be enhanced by a large Al_2O_3 concentration in the glass. In the clay-water mixture these saturation effects are must less pre-

dominant. Wet clay attacks the waste forms faster than the clay-water mixture, although the corrosion rates tend to decrease with time in both clay media. In general, no simple Arrhenius-type temperature dependence for the corrosion behavior is found for the interval between 40 and 200°C.

29239 **Isolation capability of a salt dome utilized for high-level waste disposal.** Hamstra, J. (Netherlands Energy Research Foundation, Petten). pp 419-428 of Scientific basis for nuclear waste management V. Lutze, W. (ed.). New York, NY; Horth-Holland (1982).

From 5. international symposium on the scientific basis for radioactive waste management; Berlin, F.R. Germany (7 Jun 1982).

It can be concluded that a high isolation capability of a salt dome that is to be used for nuclear waste disposal will be dependant of the following prerequisites: the salt dome should have its top rock salt at about 200 m depth or more, should be sufficiently large in its dimensions and should have clearly reached its post-diapiric stage; the repository is to be developed carefully at greater depth and leaving a large isolation shield of at least 200 m thickness over and around the emplaced waste; and the abandonment and closure of the repository and the two shaft constructions is to be done carefully too. The conclusion then is that the only phenomenon that could be considered realistic in creating a future breach in the isolation shield will be a continuous subrosion process. Its low dissolutioning rate in the order of one meter every 100,000 years to one meter every million years is a good yardstick for the high isolation capability of the salt dome. The prediction then is that if the prerequisites can be fullfilled the isolation capability will fall outside the scale of human chronology and approach infinity.

29240 **Dissolution rate of salt domes on the basis of interpretation of measured salinity profiles.** Jenson, K.E.L. (ELSAM, Fredericia, Denmark). pp 429-438 of Scientific basis for nuclear waste management V. Lutze, W. (ed.). New York, NY; Horth-Holland (1982).

From 5. international symposium on the scientific basis for radioactive waste management; Berlin, F.R. Germany (7 Jun 1982).

Analytical solutions are described for calculation of salt concentrations in ground water corresponding to a certain dissolution rate of the dome. By using these solutions a method is described, which makes it possible to determine rate of dissolution, ground water velocity, and dispersivity in the strata just above cap rock on basis of measured salinity profiles above the dome. The method is applied on the Danish salt dome Mors located in the northern part of Jutland. The cap rock is located at a depth of 600 m with limestone strata above. Interpretation of salinity profiles in the limestone just above cap rock gives a transverse dispersivity of 20 m in the limestone. The pore water velocity, here determined entirely on basis of measured salinity profiles, is found to be about 0.3 mm/y, which corresponds largely to that derived from measured permeabilities in the limestone. The corresponding average dissolution rate for the dome is determined to 0.0004 mm/y.

29241 **Low-gradient permeability testing of fine-grained marine sediments.** Silva, A.J.; Hetherman, J.R.; Calnan, D.I. (Univ of RI, Kingston, USA). *American Society for Testing and Materials, Special Technical Publication;* 121-136(1981). (CONF-7906121—).

From Permiability and groundwater containment transport symposium; Philadelphia, PA, USA (17 Jun 1979).

An apparatus is described which is used to determine the consolidation and permeability characteristics of a wide range of deep sea sediments. The unit can also be used to study temperature effects in the range of 2 to 200° C. Rather accurate readings of fine-grained sediment are possible. Test procedures as well as some experimental results are also reported. 23 refs.

29242 **Geologic investigations of the WIPP site: overview and issues.** Powers, D.W. (Sandia National Lab., Albuquerque, NM). pp 119-122 of Environmental geology and hydrology in New Mexico. Wells, S.G.; Lambert, W. (eds.). Albuquerque, NM; New Mexico Geological Society, Inc. (1981).

The Waste Isolation Pilot Plant (WIPP) is planned for the disposal of radioactive defense waste in bedded salt of southeastern New Mexico. Since 1975, the geologic investigations have progressed through preliminary site selection and geologic characterization phases; we are now primarily concerned with the long-term geological processes that may affect the site. These processes are grouped by hydrology, dissolution, geochemical, tectonic, and climatic mechanisms. Issues regarding isolation at the WIPP are usually grouped according to these processes or human intrusion. Combinations of human and water intrusion are the most likely ways of releasing radioactivity from the WIPP to the biosphere. The issues thus raised concern how well the hydrology is or must be known, whether resources will attract unacceptable human intrusion, and how geologic processes may enhance release of radionuclides. Analysis of these processes so far does not indicate that radioactive material will be released from the repository in significant amounts. The main issue (what are the consequences of the WIPP to the biosphere?) is satisfied, therefore, in spite of the possibility that unusual events, such as human intrusion, can occur.

29243 **Geohydrology of the proposed Waste Isolation Pilot Plant site in southeastern New Mexico.** Mercer, J.W. (U.S. Geological Survey, Albuquerque); Gonzalez, D.D. pp 123-132 of Environmental geology and hydrology in New Mexico. Wells, S.G.; Lambert, W. (eds.). Albuquerque, NM; New Mexico Geological Society, Inc. (1981).

The proposed site for the U.S. Department of Energy's Waste Isolation Pilot Plant (WIPP) is in the Los Medanos area located about 40 km east of Carlsbad, in eastern Eddy County, NM. Geohydrologic data have been collected from this area since 1972, and the data will be used as part of a study evaluating the feasibility of storing defense-associated transuranic wastes in bedded salt at a depth of 655 m. The salt beds are within the Salado Formation of Permian age. The study presented includes the determination of ground-water flow boundaries; potentiometric heads; ground-water chemistry; and hydraulic properties through pump, slug, pressure-pulse, and tracer tests. Data collected during drilling and testing 30 hydrologic holes have indicated three zones above the Salado Formation that could potentially transport wastes to the biosphere if the proposed facility is breached. These zones include the Magenta and Culebra Dolomite members of the Rustler Formation and the contact zone between the Rustler and Salado formations. (JMT)

29244 **Standard leach tests for nuclear waste materials.** Strachan, D.M.; Barnes, B.O.; Turcotte, R.P. (Pacific Northwest Lab., Richland, WA). pp 347-354 of Scientific basis for nuclear waste management. Volume 3. Moore, J.G. (ed.). New York, NY; Plenum Publishing Corporation (1981). Contract AC06-76RL01830.

Five related leach tests have been proposed by the Nuclear Waste Materials Characterization Center at the Pacific Northwest Laboratory to study time dependent leaching of waste forms. The tests were MCC-1 Static Low Temperature Test; MCC-2 High Temperature Static Test; MCC-3 Solubility Test and Flow Tests, MCC-4 Low Flow Test, and MCC-5 Soxhlet Test. The first four tests included temperature as a variable and the use of three standard leachants. Three of the tests were static and two studied leaching under dynamic conditions. All tests required multielement analyses and measurement of the pH of the leachate. This suite of tests satisfied the needs for waste form comparison and for comprehensive information about the leaching behavior of waste forms under various conditions. These tests were discussed in detail and representative data that had been collected were reported. 4 figures. (DP)

29245 **Radioactive waste management.** Blomek, D. (Oak Ridge National Lab., TN (USA)). pp 97-106 of Nuclear power safety. Rast, D.; Viver, L. (eds.). Moscow, USSR; Atomizdat (1980). (In Russian)

The prospects of nuclear power development in the USA up to 2000 and the problems of the fuel cycle high-level radioactive waste processing and storage are considered. The problems of liquid and solidified radioactive waste transportation and their disposal in salt deposits and other geologic formations are discussed. It is pointed out that the main part of the high-level radioactive wastes are produced at spent fuel reprocessing plants in the form of complex aqueous mixtures. These mixtures contain the decay prod-

ucts of about 35 isotopes which are the nuclear fuel fission products, about 18 actinides and their daughter products as well as corrosion products of fuel cans and structural materials and chemical reagents added in the process of fuel reprocessing. The high-level radioactive waste management includes the liquid waste cooling which is necessary for the short and middle living isotope decay, separation of some most dangerous components from the waste mixture, waste solidification, their storage and disposal. The conclusion is drawn that the successful solution of the high-level radioactive waste management problem will permit solving the problem of the fuel cycle radioactive waste management as a whole. The salt deposits, shales and clays are the most suitable for radioactive waste disposal.

0530 Environmental Aspects

REFER ALSO TO CITATION(S) 29121, 29122, 29123, 29133, 29134, 29146, 29149, 29150, 29156, 29157, 29218, 29219, 29220, 29221, 29222, 29223, 29224, 29225, 29226, 29227, 29228, 29229, 29230, 29231, 29232, 29233, 29234, 29241, 29971, 30357, 30374, 30590, 30593

29246 (NUREG/CP—0028-Vol.3, pp 379-410) **Predictability of solute transport in diffusion-controlled hydrogeologic regimes.** Gillham, R.W.; Cherry, J.A. (Univ. of Waterloo, Ontario). Mar 1983. NTIS, PC A19/MF A01 - GPO $11.00.

From Symposium on low level waste disposal; Washington, DC, USA (29 Sep 1982).

Hydrogeologic regimes that are favourable for the subsurface management of low-level radioactive wastes must have transport properties that will limit the migration velocity of contaminants to some acceptably low value. Of equal importance, for the purpose of impact assessment and licensing, is the need to be able to predict, with a reasonable degree of certainty and over long time periods, what the migration velocity of the various contaminants of interest will be. This paper presents arguments to show that in addition to having favourable velocity characteristics, transport in saturated, diffusion-controlled hydrogeologic regimes is considerably more predictable than in the most common alternatives. The classical transport models for unsaturated, saturated-advection-controlled and saturated-diffusion-controlled environments are compared, with particular consideration being given to the difficulties associated with the characterization of the respective transport parameters. Results are presented which show that the diffusion of non-reactive solutes and solutes that react according to a constant partitioning ratio (K/sub d/) are highly predictable under laboratory conditions and that the diffusion coefficients for the reactive solutes can be determined with a reasonable degree of accuracy from independent measurements of bulk density, porosity, distribution coefficient and tortuosity. Field evidence is presented which shows that the distribution of environmental isotopes and chloride in thick clayey deposits is consistent with a diffusion-type transport process in these media. These results are particularly important in that they not only demonstrate the occurrence of diffusion-controlled hydrogeologic regimes, but they also demonstrate the predictability of the migration characteristics over very long time periods.

29247 (NUREG/CR—3027) **Overland erosion of uranium-mill-tailings impoundments: physical processes and computational methods.** Walters, M.H. (Pacific Northwest Lab., Richland, WA (USA)). Mar 1983. Contract AC06-76RL01830. 58p. (PNL—4523). NTIS, PC A04/MF A01 - GPO. Order Number DE83010379.

The surface runoff and erosional processes of watersheds caused by rainfall-runoff are reviewed. Soil properties, topography, and rainstorm distribution are discussed with respect to their effects on soil erosion. The effects of climate and vegetation are briefly presented. Regression models and physical process simulation models are reviewed.

29248 (NUREG/CR—3062) **Status of geochemical problems relating to the burial of high-level radioactive waste, 1982.** Apps, J.A.; Carnahan, C.L.; Lichtner, P.C.; Michel, M.C.; Perry, D.; Silva, R.J.; Weres, O.; White, A.F. (Lawrence Berkeley Lab., CA (USA)). Mar 1983. Contract AC03-76SF00098. 380p. (LBL—15103). NTIS, PC A17/MF A01 - GPO $9.50. Order Number DE83010251.

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Geochemistry research supporting high-level radioactive waste burial in underground repositories is evaluated. General research covering the whole repository includes the bounding of physical and chemical conditions in the repository environment, estimation of toxic radionuclides present in spent fuel and high-level waste at various times after 1000 years, the forms in which radionuclides might be transported in groundwater, the mechanisms by which radionnuclides are retarded, and transport models incorporating chemical reactions. Specific issues relating to the backfill, near field, and far field are also examined. These include low-permeability backfills, diffusional radionuclide transport through backfills (both with and without sorption), the long-term criticality potential in a repository, near-field phase changes and their impact on rock geomechanical properties and radionuclide migration, the effect of temperature gradients on host rock permeability, and, finally, the assessment of groundwater dating to determine groundwater flow rates. Each evaluation results in a series of conclusions and recommendations. The recommendations are prioritized, and further research needed to resolve current uncertainties is suggested.

29249 (NUREG/CR—3124) **Laboratory measurements of contaminant attenuation of uranium mill tailings leachates by sediments and clay liners.** Serne, R.J.; Peterson, S.R.; Gee, G.W. (Pacific Northwest Lab., Richland, WA (USA)). Apr 1983. Contract AC06-76RL01830. 124p. (PNL—4605). NTIS, PC A06/MF A01 - GPO $6.00. Order Number DE83010802.

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We discuss FY82 progress on the development of laboratory tools to aid in the prediction of migration potential of contaminants present in acidic uranium mill tailings leachate. Further, empirical data on trace metal and radionuclide migration through a clay liner are presented. Acidic uranium mill tailings solution from a Wyoming mill was percolated through a composite sediment called Morton Ranch Clay liner. These laboratory columns and subsequent sediment extraction data show: (1) As, Cr, Pb, Ag, Th and V migrate very slowly; (2) U, Cd, Ni, Zn, Fe, Mn and similar transition metals are initially immobilized during acid neutralization but later are remobilized as the tailings solution exhausts the clay liner's acid buffering capacity. Such metals remain immobilized as long as the effluent pH remains above a pH value of 4 to 4.5, but they become mobile once the effluent pH drops below this range; and (3) fractions of the Se and Mo present in the influent tailings solution are very mobile. Possible controlling mechanisms for the pH-dependent immobilization-mobilization of the trace metals are discussed. More study is required to understand the controlling mechanisms for Se and Mo and Ra for which data were not successfully collected. Using several column lengths (from 4.5 to 65 cm) and pore volume residence times (from 0.8 to 40 days) we found no significant differences in contaminant migration rates or types and extent of controlling processes. Thus, we conclude that the laboratory results may be capable of extrapolation to actual disposal site conditions.

29250 (ONWI—192) **Environmental characterization report for the Gulf Interior Region Louisiana study area.** (Bechtel National, Inc., San Francisco, CA (USA)). Oct 1982. Contract AC06-76RL01830. 261p. NTIS, PC A12/MF A01. Order Number DE83010526.

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This report is published as a product of the National Waste Terminal Storage (NWTS) Program. The objective of this program is the development of terminal waste storage facilities in deep, stable geologic formations for high-level nuclear waste, including spent fuel elements from commercial power reactors and transuranic nuclear waste for which the federal government is responsible. The report is part of the area study phase and contains environmental information for the Louisiana Study Area of the Gulf Interior Region acquired from federal, state, and regional agencies. The data in this report meet the requirements of predetermined survey plans and will be used in determining locations of approximately 80 square kilometers (30 square miles) that will be further characterized. Information on surface water, atmosphere, background radi-

ation, natural ecosystems, agricultural systems, demography, socioeconomics, land use, and transportation is presented. The environmental characterization will ensure that data on environmental values required by the National Environmental Policy Act (NEPA) of 1969 are available.

29251 **(ONWI—193) Environmental characterization report for the Gulf Interior Region Mississippi study area.** (Bechtel National, Inc., San Francisco, CA (USA)). Oct 1982. Contract AC06-76RL01830. 252p. NTIS MF A01. Order Number DE83010525.

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This report is published as a product of the National Waste Terminal Storage (NWTS) Program. The objective of this program is the development of terminal waste storage facilities in deep, stable geologic formations for high-level nuclear waste, including spent fuel elements from commercial power reactors and transuranic nuclear waste for which the federal government is responsible. The report is part of the area study phase and contains environmental information for the Mississippi Study Area of the Gulf Interior Region acquired from federal, state, and regional agencies. The data in this report meet the requirements of predetermined survey plans and will be used in determining locations of approximately 80 square kilometers (30 square miles) that will be further characterized. Information on surface water, atmosphere, background radiation, natural ecosystems, agricultural systems, demography, socioeconomics, land use, and transportation is presented. The environmental characterization will ensure that data on environmental values required by the National Environmental Policy Act (NEPA) of 1969 are available.

29252 **(ONWI—194) Environmental characterization report for the Gulf Interior Region, Texas study area.** (Bechtel National, Inc., San Francisco, CA (USA)). Oct 1982. Contract AC06-76RL01830. 236p. NTIS, PC A11/MF A01. Order Number DE83010220.

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This report is published as a product of the National Waste Terminal Storage (NWTS) Program. The objective of this program is the development of terminal waste storage facilities in deep, stable geologic formations for high-level nuclear waste, including spent fuel elements from commercial power reactors and transuranic nuclear waste for which the federal government is responsible. The report is part of the area study phase and contains environmental information for the Texas Study Area of the Gulf Interior Region acquired from federal, state, and regional agencies. The data in this report meet the requirements of predetermined survey plans and will be used in determining locations of approximately 80 square kilometers (30 square miles) that will be further characterized. Information on surface water, atmosphere, background radiation, natural ecosystems, agricultural systems, demography, socioeconomics, land use, and transportation is presented. The environmental characterization will ensure that data on environmental values required by the National Environmental Policy Act (NEPA) of 1969 are available.

29253 **(SAND—83-0434) Meteorological tower data: Grand Junction Tailings Site, Colorado. Final report, January-August 1982.** Church, H.W. (Sandia National Labs., Albuquerque, NM (USA)). Mar 1983. Contract AC04-76DP00789. 7p. (TTC—0427). NTIS, PC E02/MF A01. Order Number DE83010897.

Includes 2 sheets of 48x reduction microfiche.

The 10-m tower system installed in 1981 at the Grand Junction abandoned uranium-mill-tailings pile continued to measure and record data through August 1982. This report presents these final data for calendar year 1982 along with some comments about the systems performance.

0540 Health And Safety

REFER ALSO TO CITATION(S) 29118, 29239, 30317, 30512, 30514, 30515, 30516

29254 **(ANL/ES—131) Radiological impacts of Jackpile-Paguate uranium mines: an analysis of alternatives of decommissioning.** Momeni, M.H.; Tsai, S.Y.H.; Yang, J.Y.; Gureghian, A.B.; Dungey, C.E. (Argonne National Lab., IL (USA)). Mar 1983. 232p. NTIS, PC A11/MF A01. Order Number DE83010687.

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Potential pathways of radiation exposure and radiation-induced genetic and somatic effects from materials at the mine complex under five alternatives of decommissioning were analyzed using UDAD and PRIM computer codes. The principal pathways of exposure included in the analysis were inhalation of airborne radionuclides, ingestion of food and water containing radionuclides, and extended exposure to gamma and beta radiation from either airborne or ground-deposited radionuclides. The alternatives of decommissioning include (A) No Action (site will be fenced, otherwise left as it is), (B) No Future Use (site will be fenced and all disturbed area will be covered with 30 cm of soil, no grazing on the site); (C1) Grazing Land Use as developed by Anaconda Company (protore, waste piles, and open pits covered with 120 cm of soil, the remainder of the disturbed areas covered with 30 cm of soil, pits backfilled 90 cm above the equilibrium groundwater recovery level, no human habitation or farming allowed on the mine site, but grazing would be allowed); (C2) Grazing Land Use as developed by US Department of the Interior (similar to Alternative C1, but the pits covered with 300 cm of soil above the groundwater recovery level); and (D) Maximum Future Use (similar to Alternative C2, except construction of commercial and industrial facilities, storage, recreation, and further mining would be allowed). Radiation doses from atmospheric transport and ingestion of radionuclides were calculated, and somatic and genetic effects in individuals living within 80 km from the mine complex were predicted. Hydrological flow patterns in the mine area were analyzed to determine the potential for future contamination of surface water and groundwater and to determine the groundwater recovery level after reclamation, thus permitting incorporation of corrective actions into the reclamation procedures.

29255 **(NUREG/CR—2422) Dosimetry and health effects self-teaching curriculum: illustrative problems to supplement the user's manual for the Dosimetry and Health Effects Computer Code.** Runkle, G.E.; Finley, N.C. (Sandia National Labs., Albuquerque, NM (USA)). Mar 1983. Contract AC04-76DP00789. 113p. (SAND—81-2488). NTIS, PC A06/MF A01 - GPO $5.50. Order Number DE83009489.

This document contains a series of sample problems for the Dosimetry and Health Effects Computer Code to be used in conjunction with the user's manual (Runkle and Cranwell, 1982) for the code. This code was developed at Sandia National Laboratories for the Risk Methodology for Geologic Disposal of Radioactive Waste program (NRC FIN A-1192). The purpose of this document is to familiarize the user with the code, its capabilities, and its limitations. When the user has finished reading this document, he or she should be able to prepare data input for the Dosimetry and Health Effects code and have some insights into interpretation of the model output.

29256 **(ORO—831) Radiological guidelines for application to DOE's Formerly Utilized Sites Remedial Action Program.** (Argonne National Lab., IL (USA)). Mar 1983. Contract W-31-109-ENG-38. 125p. NTIS, PC A06/MF A01. Order Number DE83011013.

The US Department of Energy has implemented a program to evaluate and, where necessary, take action to protect the public from contamination at sites that were used in the past to process and/or store radioactive materials for the former US Army Corps of Engineers Manhattan Engineer District or the US Atomic Energy Commission. The program is identified as the Formerly Utilized Sites Remedial Action Program (FUSRAP). This document describes methods considered appropriate for the evaluation

of health effects that might possible be caused by radioactive contamination at FUSRAP sites. This assessment methodology is applied to a typical site for the purposeof deriving guidelines for the cleanup of contaminated soil. Additional guidance is provided for planning site-specific remedial action that is consistent with the overall objectives of FUSRAP.

29257 **(ORO—832) Pathways analysis and radiation-dose estimates for radioactive residues at formerly utilized MED/AEC sites.** Gilbert, T.L.; Chee, P.C.; Knight, M.J.; Peterson, J.M.; Roberts, C.J.; Robinson, J.E.; Tsai, S.Y.H.; Yuan, Y.C. (Argonne National Lab., IL (USA)). Mar 1983. Contract W-31-109-ENG-38. 250p. NTIS, PC A11/MF A01. Order Number DE83011018.

Methods of analysis are developed for estimating the largest individual radiation dose that could result from residual radioactivity at sites identified by the Formerly Utilized Sites Remedial Action Program (FUSRAP) of the US Department of Energy. Two unique aspects of the methods are (1) a systematic structuring of the radiation pathways analysis into source terms, source-to-exposure analysis, and exposure-to-dose analysis, and (2) the systematic use of data on the average concentrations of naturally occurring radionuclides in soil, food, and the human body in order to assess the validity of model calculations and obtain more realistic values. The methods are applied to a typical FUSRAP site in order to obtain generic source-to-dose (D/S) conversion factors for estimating the radiation dose to the maximally exposed individual from a known concentration of radionuclides in the soil. The D/S factors are used to derive soil guidelines, i.e., the limiting concentrations of radionuclides at a typical FUSRAP site that are unlikely to result in individual dose limits that exceed generally accepted radiation protection standards. The results lead to the conclusion that the soil guidelines should not exceed 17, 75, and 300 pCi/g for Ra-226, U-238, and Th-230, respectively.

29258 **(SAND—82-1277) Scenarios for consequence assessments of radioactive-waste repositories at Yucca Mountain, Nevada Test Site.** Hunter, R.L.; Barr, G.E.; Bingham, F.W. (Sandia National Labs., Albuquerque, NM (USA)). Mar 1983. Contract AC04-76DP00789. 137p. NTIS, PC A07/MF A01. Order Number DE83010684.

This report describes the construction and preliminary analysis of nearly 4000 scenarios for the release of radioactive waste from a hypothetical repository at Yucca Mountain, Nevada Test Site. Preliminary analyses were carried out for four rock units: the Topopah Spring Member of the Paintbrush Formation, the bedded tuffs of the Calico Hills, and the Bullfrog and Tram Members of the Crater Flat Formation. Only a few of the scenarios were found to have appreciable probabilities of occurrence. Preliminary modeling of certain possible release mechanisms shows that convective cells can form in saturated tuff. The scenarios can be used to guide future consequence analyses and exploratory programs.

0550 Regulations

REFER ALSO TO CITATION(S) 29103, 29110, 29213, 29987

29259 **(DOE/DP—0001/11) Strategic special nuclear material inventory differences. Semi-annual report.** (USDOE Assistant Secretary for Defense Programs, Washington, DC. Office of Safeguards and Security). Jan 1983. 24p. NTIS, PC A02/MF A01. Order Number DE83010264.

This report provides and explains the differences between the amounts of nuclear materials charged to DOE facilities and the amounts that could be physically inventoried. This report covers data for the period from October 1, 1981 through March 31, 1982, and includes accounting corrections for data from earlier periods. All Inventory Differences reported have been analyzed, investigated when necessary, and resolved. These data and explanations, together with the absences of physical indications of any theft attempt, support a finding that during this period no theft or diversion of strategic special nuclear material has occurred.

29260 **(DOE/IG—0166) Two versions of the Principles of Understanding between the Department of Energy and the State of Louisiana.** (USDOE Office of Inspector General, Washington, DC). 21 Jul 1981. 35p. USDOE-TIC, PO Bx 62, Oak Ridge, TN 37830.

Portions are illegible in microfiche products; Report to The Secretary.

An investigation showed that the first version (February 27, 1978) was superseded by the second version that was executed by the same persons on or soon after February 27, 1978, in order to change language not acceptable to the State of Louisiana. Concerning nuclear waste repository. Persons familiar with the language of nuclear technology assert that the terms nuclear waste repository for long-term disposal and nuclear waste repository have the same meaning; thus the second version of the Priniciples of Understanding continued to express the same intent of the Department and the State of Louisiana before modification. Comments by the Assistant Secretary for Nuclear Energy are incorporated into this report. (PSB)

29261 **(DOE/IG—0191) Management of the uranium mill tailings remedial action program.** (USDOE Office of Inspector General, Washington, DC). 18 Mar 1983. 23p. K. Order Number DE83009214.

Report to The Secretary.

Where review of implementation actions under the 1978 Uranium Mill Tailings Radiation Control Act showed an excessive cost for small benefit to the public health and showed excessive concern with document preparation, the IG restated program objectives as the Cost Reduction Study; the development of a new, lower, comprehensive cost estimate; the assignment of additional staff to the UMTRA Project Office; and the agreement to monitor the adequacy of the staffing level. Recommendations were given to use EPA's supplemental standards when the cost is clearly unreasonably high compared with the benefits; to select and use the most cost-effective option that meets the EPA standards, with selected consideration for the use of sealants, filtration, and ventilation devices in appropriate circumstances; to rank and select sites and vicinity properties for remedial action according to true public health risks only. Higher risk properties should receive first remedial action. Corrective actions are reported. (PSB)

29262 **(NUREG/CR—2819) Statistical analysis of cumulative shipper-receiver data.** Rose, D.M.; Scholz, F.W. (Boeing Computer Services Co., Tukwila, WA (USA)). Apr 1983. 190p. (BCS—40384-0). NTIS, PC A09/MF A01 - GPO $7.00. Order Number DE83901628.

This report presents a method of constructing a test for the detection of nuclear material diversions over a series of n shipments. The available data are the shipper-receiver differences (SRD's) which are assumed to be multivariate normally distributed with known covariance matrix. Given a specific diversion scenario the most powerful test is derived. The least favorable scenario with respect to NRC detection is identified and the most powerful test against this scenario is found. The power function of this test depends only on the total amount diverted and not on the particular scenario chosen. This test maximizes among all level α tests, the minimum power over all scenarios with total diversion at least m. For various diversion scenarios, assuming independent SRDs, the power of the max-min test is compared to that of tests that are specific for each of these scenarios. Assuming the SRD's are independent with unknown variances, the max-min test is modified using Satterthwaite's approximation. The quality of this latter approximation is investigated for a range of parameter sets.

29263 **(SAAS—283) Computer processing of nuclear material data in the German Democratic Republic - as of August 1980.** Burmester, M.; Helming, M. (Staatliches Amt fuer Atomsicherheit und Strahlenschutz, Berlin (German Democratic Republic)). 1981. 23p. NTIS (US Sales Only), PC A02/MF A01. Order Number DE83701503.

A description is given of the computer-based processing of safeguards information within the frame of the State System of Accounting for and Control of Nuclear Material. Software includes the programmes ICR, PILMBR, LISTE, POL, DELE and SIP

which produce the required reports to the IAEA on magnetic type and in the form of printouts, and provide a series of relevant information and data essentially facilitating the fulfilment of national obligations in the field of nuclear material control.

06 FUSION FUELS

0602 Processing

29264 **(UCID—19689) Mechanical properties of vapor-deposited thin metallic films: a status report.** Adler, P.H. (Lawrence Livermore National Lab., CA (USA)). 17 Dec 1982. Contract W-7405-ENG-48. 22p. NTIS, PC A02/MF A01. Order Number DE83010981.

The mechanical properties of vapor-deposited thin metallic films are being studied in conjunction with the target fabrication group associated with the laser-fusion energy program. The purpose of the work is to gain an understanding as to which metals are structurally best suited to contain a glass microsphere filled with deuterium-tritium (D-T) gas at large internal pressures.

07 ISOTOPE AND RADIATION SOURCE TECHNOLOGY

0701 Physical Isotope Separation

REFER ALSO TO CITATION(S) 30151

29265 **(DOE/NDC—29) Stable isotope research pool inventory.** (Oak Ridge National Lab., TN (USA)). Mar 1983. Contract W-7405-ENG-26. 58p. (INDC(USA)—90/G; EANDC(US)—215/A). NTIS, PC A04/MF A01. Order Number DE83010189.

This report contains a listing of electromagnetically separated stable isotopes which are available for distribution within the United States for non-destructive research use from the Oak Ridge National Laboratory on a loan basis. This inventory includes all samples of stable isotopes in the Materials Research Collection and does not designate whether a sample is out on loan or in reprocessing. For some of the high abundance naturally occurring isotopes, larger amounts can be made available; for example, Ca-40 and Fe-56.

29266 **Vanadium hydride deuterium-tritium generator.** Christensen, L.D. (to Dept. of Energy). US Patent 4,336,226. 22 Jun 1982. Filed date 13 Mar 1980. vp.

PAT-APPL-129867.

A pressure controlled vanadium hydride gas generator to provide deuterium-tritium gas in a series of pressure increments. A high pressure chamber filled with vanadium-deuterium-tritium hydride is surrounded by a heater which controls the hydride temperature. The heater is actuated by a power controller which responds to the difference signal between the actual pressure signal and a programmed pressure signal.

29267 **^{13}C isotope separation by laser excitation of CO.** Bergman, R.C.; Rich, J.W. Buffalo, NY; Calspan Advanced Technology Center (1979). 5p.

A CO laser is used to excite the vibrational mode of CO in a CO/Ar mixture flowing through an absorption cell. The CO reacts to form CO_2, C_3, and C_3O_2. The products are isotopically enriched in ^{13}C.

0702 Radiation Sources

REFER ALSO TO CITATION(S) 29993, 30200, 30201, 30202, 30203, 30241, 30745, 30787, 30805

29268 **(ANL—82-80) Proceedings of the sixth meeting of the international collaboration on advanced neutron sources.** (Argonne National Lab., IL (USA)). Jan 1983. Contract W-31-109-ENG-38. 671p. (CONF-8206118—). NTIS, PC A99/MF A01. Order Number DE83008718.

From 6. annual international collaboration of advanced neutron sources meeting; Argonne, IL, USA (28 Jun 1982).

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Papers were presented in four major areas: status reports from ICANS laboratories and projects; instrumentation; targets and moderators designs and tests; and nuclear data and codes. Of the 49 papers in the proceedings, 10 were prepared previously for the data base, and 32 were prepared for this issue. (GHT)

29269 (ANL—82-80, pp 217-235) **Rotating crystal pulse shaper for use on a pulsed neutron source.** Carpenter, J.M. (Argonne National Lab., IL); Carlile, C.J. Jan 1983. NTIS, PC A99/MF A01.

From 6. annual international collaboration of advanced neutron sources meeting; Argonne, IL, USA (28 Jun 1982).

A pulse shortening device is described for use on pulsed thermal neutron sources. The device employs rotating single crystals and has applications in the design of high resolution cold neutron spectrometers.

29270 (ANL—82-80, pp 315-326) **Progress on the SNS target station.** Carne, A. (Rutherford Appleton Lab., Chilton, England). Jan 1983. NTIS, PC A99/MF A01.

From 6. annual international collaboration of advanced neutron sources meeting; Argonne, IL, USA (28 Jun 1982).

This review gives progress and modifications covering the last eighteen months, under the five broad areas of target, target assembly, control system, bulk shield and remote handling. Finally a discussion of additional facilities to the SNS is presented.

29271 (ANL—82-80, pp 327-338) **Cryogenic moderator design.** Diplock, B.R. (Rutherford Appleton Lab., Chilton, England). Jan 1983. NTIS, PC A99/MF A01.

From 6. annual international collaboration of advanced neutron sources meeting; Argonne, IL, USA (28 Jun 1982).

This paper describes the present design of the two cold moderators to be built for the Spallation Neutron Source. It discusses the reasons behind a number of the design features and highlights several problem areas requiring solutions before a final design can be constructed.

29272 (ANL—82-80, pp 357-373) **Thermofluid dynamics of the liquid lead-bismuth target for the spallation neutron source at SIN.** Takeda, Y. (Schweizerisches Institut fuer Nuklearforschung, Villigen, Switzerland). Jan 1983. NTIS, PC A99/MF A01.

From 6. annual international collaboration of advanced neutron sources meeting; Argonne, IL, USA (28 Jun 1982).

Natural convection of liquid Lead-Bismuth Eutectics (LBE) has been numerically simulated and thermal-fluid behaviors of a target were studied. The calculation was based on the Boussinesq approximation and made for a simple geometry of a vertical cylindrical container with a distributed internal heat generation. Studies have been made of the effects of the target height, beam power and adiabatic side wall. They showed that the natural convection is effective for transporting heat and the vertical cylindrical target is practicable.

29273 (ANL—82-80, pp 375-389) **Developing an optimum target design for a high energy spallation neutron source with respect to mechanical and thermal constraints.** Stelzer, J.F. (KFA, Juelich, Germany). Jan 1983. NTIS, PC A99/MF A01.

From 6. annual international collaboration of advanced neutron sources meeting; Argonne, IL, USA (28 Jun 1982).

On the search for a suited target design different variants have been systematically studied with respect to their temperature and rigidity behavior. The calculations dealt with the temperatures and stresses in the maximally parts and were carried out using the finite element method. The final solution is a rotating, internally water-cooled wheel of 2.5 m outer diameter, carrying about 9000 rods filled with lead. There are three highly loaded areas: the outer housing, the beam window and the lead-filled target rods. The construction of the mathematical models is shown. The results are in-

troduced and discussed. The design satisfies the mechanical demands.

29274 (ANL—82-80, pp 391-405) **Grooved cold moderator tests.** Inoue, K. (Hokkaido Univ., Sapporo, Japan); Kiyanagi, Y.; Iwasa, H.; Watanabe, N.; Ikeda, S.; Carpenter, J.M.; Ishikawa, Y. Jan 1983. NTIS, PC A99/MF A01.

From 6. annual international collaboration of advanced neutron sources meeting; Argonne, IL, USA (28 Jun 1982).

We performed some grooved cold moderator experiments for methane at 20 K by using the Hokkaido University linac to obtain information to be used in the planning of the KENS-I' project. Cold neutron gains, spatial distribution of emitted beams and time distribution of the neutrons in the grooved cold moderator were measured. Furthermore, we assessed the effects of the grooved cold moderator on the performances of the spectrometers presently installed at the KENS-I cold source. We concluded that the grooved cold moderator benefited appreciably the performances of the spectrometers.

29275 (ANL—82-80, pp 431-439) **Time-structure of thermal neutron leakage from fast and slow moderators for spallation neutron sources.** Bauer, G.S. (KFA, Juelich GmbH, Germany); Conrad, H.M.; Gruenhagen, K.; Spitzer, H.; Gompf, F.; Reichardt, W.; Fischer, W.E. Jan 1983. NTIS, PC A99/MF A01.

From 6. annual international collaboration of advanced neutron sources meeting; Argonne, IL, USA (28 Jun 1982).

The dwell-times of neutrons slowed down either in small polyethylene moderators or a large D_2O volume have been measured. The fast neutrons have been produced by bombarding lead, lead-bismuth, depleted uranium and tungsten targets of slab or cylindrical shape with short pulses of 490 MeV protons. Lead and beryllium reflectors have been employed for the rectangular shaped grooved polyethylene moderators. The geometry-adapted (jagged) polyethylene moderators used with the cylindrical target have been measured only in D_2O-reflected configuration. The essential result of the numerical analysis of about 40 target-moderator-reflector configurations tested is that for the fast (light hydrogen) moderators the most intense flux component decays in 100 μs or less.

29276 (ANL—82-80, pp 441-459) **Some aspects of the neutronics of the SIN neutron source.** Atchison, F. (Schweizerisches Institut fuer Nuklearforschung, Villigen, Switzerland); Fischer, W.E.; Sigg, B. Jan 1983. NTIS, PC A99/MF A01.

From 6. annual international collaboration of advanced neutron sources meeting; Argonne, IL, USA (28 Jun 1982).

Some results from both experiment and calculation, obtained as part of the optimization study for the SIN neutron source, are presented.

29277 (ANL—82-80, pp 529-550) **High-energy fission models validation and comparison with experiments.** Armstrong, T.W.; Cloth, P.; Filges, D.; Neef, R.D. (Kernforschungsanlage Juelich GmbH, Germany). Jan 1983. NTIS, PC A99/MF A01.

From 6. annual international collaboration of advanced neutron sources meeting; Argonne, IL, USA (28 Jun 1982).

Calculations including the high energy fission models were performed. Comparisons on BNL-Cosmotron arrangements of thermal neutron peak fluxes in the H_2O-moderator for lead and depleted uranium targets are given for different proton beam energies (540, 960, 1470 MeV) and two B_0-parameters (8 and 14 MeV) of the level density formula. Preliminary results of neutron spectra measurements for thin uranium targets are compared with HETC calculations at 590 MeV incident proton beam energy. The residual mass distributions are determined in thin uranium targets for proton beam energies of 0.3, 1.0, and 2.9 GeV. The calculations are done using the Rutherford and Appleton Laboratory high energy fission model (RAL) and are compared with respective calculations of the ORNL-model by Alsmiller et al.

29278 (ANL—82-80, pp 551-570) **Measurements of the spallation and fission product production for depleted uranium and natural lead targets bombarded by 1100 MeV protons.** Amian, W.; Peek, N.F.; Shadoan, D.J. (Kernforschungsanlage Juelich GmbH, Germany). Jan 1983. NTIS, PC A99/MF A01.

From 6. annual international collaboration of advanced neutron sources meeting; Argonne, IL, USA (28 Jun 1982).

In order to simulate the spallation source target, 3 cm diameter by 1 mm thick disks of natural lead and depleted uranium were irradiated at 1100 MeV proton energy. The targets were inbedded between 5 cm thick bricks of the respective material. Gamma-ray spectrometric methods of gamma-peak and halflife analysis were developed to deduce mass yield distributions of the radionuclides produced. Both for lead and uranium fission products have been observed. The mass yield distributions and axial distributions of some isotopes are given. For lead the total production rates of some isotopes with a 100 x 50 x 450 mm target block are given.

29279 (ANL—82-80, pp 583-603) **Measured and calculated neutron yields for 100 MeV protons on thick targets of Pb and Li.** Jones, R.T. (Chalk River Nuclear Labs., Ontario); Lone, M.A.; Okazaki, A.; Townes, B.M.; Santry, D.C.; Earle, E.D.; Lee, J.K.P.; Robson, J.M.; Moore, R.B.; Raut, V. Jan 1983. NTIS, PC A99/MF A01.

From 6. annual international collaboration of advanced neutron sources meeting; Argonne, IL, USA (28 Jun 1982).

The neutron yield per proton from thick targets of lead and lithium irradiated with 100 MeV protons has been measured and calculated. The water bath method was used to measure the neutron production, and a Faraday cup for the beam current determination. Measured yields are 0.343 +- 0.021 for lead and 0.123 +- 0.007 for lithium. Corresponding yields calculated with the nucleon-meson transport code NMTC are 0.363 +- 0.002 and 0.160 +- 0.001. Measured and calculated thermal neutron distributions in the water bath are also compared.

29280 (ANL—82-80, pp 619-627) **How much thermal neutron flux is gained using deuterons instead of protons.** Bauer, G.S. (KFA Juelich GmbH, Germany); Conrad, H.M.; Gruenhagen, K.; Spitzer, H.; Milleret, G. Jan 1983. NTIS, PC A99/MF A01.

From 6. annual international collaboration of advanced neutron sources meeting; Argonne, IL, USA (28 Jun 1982).

The neutron leakage fluxes from hydrogeneous moderators have been measured as a function of the energy of protons and deuterons impinging on lead and depleted uranium targets. A gain in thermal neutron yields has been observed in any case using deuterons. The gains depend on both primary particle energies and target materials. The economic advantage of employing deuterons instead of protons can be stated in two ways: firstly, using 850 MeV deuterons and a lead target the same thermal leakage flux is obtained as with 1100 MeV protons, or secondly, using 1100 MeV deuterons a flux increase of about 30% is gained. The figures for a uranium target are 900 MeV deuterons or 23% flux gain respectively.

29281 (ANL—82-80, pp 629-638) **Monte Carlo study of the energy deposition of a flux of spallation neutrons in various samples.** Pepin, M. (Schweizerisches Institut fuer Nuklearforschung, Villigen, Switzerland). Jan 1983. NTIS, PC A99/MF A01.

From 6. annual international collaboration of advanced neutron sources meeting; Argonne, IL, USA (28 Jun 1982).

The flux of spallation neutrons produced on a sample by a 10 μA beam of 520 MeV protons incident on a 25 cm long cylindrical lead target of 7.7 cm radius was estimated with the Monte Carlo codes HET and O5R. In order to save computing time, the simulation was done in two steps, and the number of high-energy neutrons in the region of interest could be enhanced at the end of the first step. The calculated flux was compared with the values measured by S. Cierjacks, M.T. Rainbow, M.T. Swinhoe, and L. Buth at 590 MeV. The energy deposed in the sample by nuclear reactions above 15 MeV and by elastic recoils was estimated for the materials Be, C, Al, Fe, Cu, W, Pb, Bi and D_2O. For a 10 μA incoming beam, the total energy deposition varies between 1.02 x 10^{-4} cal/cm^{3}sec for Bi and 3.30 x 10^{-4} cal/cm^{3}sec for D_2O. The

fraction of this energy which is deposed through elastic recoils varies from 6% for Bi to 88% for D_2O.

29282 (ANL—82-80, pp 639-649) **Possible use of copper spallation reactions to measure high energy particle spectra in shielding experiments.** Amian, W.; Drueke, V.; Kloda, M.; Litzow, W. (Kernforschungsanlage Juelich GmbH, Germany). Jan 1983. NTIS, PC A99/MF A01.

From 6. annual international collaboration of advanced neutron sources meeting; Argonne, IL, USA (28 Jun 1982).

The formation of spallation products in copper oils has been used to derive the high energy part of the neutron energy spectra from spallation reactions. Spectra for lead and uranium spallation targets have been measured. The method derives the neutron energy spectra by unfolding the measured residual nuclei in the energy region of 100 MeV up to 650 MeV with reasonable precision, which is illustrated by the confidence limits of the neutron spectra derived.

29283 (CONF-830205—25) **Applications developed for byproduct ^{85}Kr and tritium.** Remini, W.C.; Case, F.N.; Haff, K.W.; Tiegs, S.M. (USDOE Assistant Secretary for Defense Programs, Washington, DC; Oak Ridge National Lab., TN (USA)). 1983. Contract W-7405-ENG-26. 5p. NTIS, PC A02/MF A01. Order Number DE83009837.

From Waste management conference; Tucson, AZ, USA (27 Feb 1983).

The radionuclides, krypton-85 and tritium, both of which are gases under ordinary conditions, are used in many applications in industries and by the military forces. Krypton-85 is produced during the fissioning of uranium and is released during the dissolution of spent-fuel elements. It is a chemically inert gas that emits 0.695-MeV beta rays and a small yield of 0.54-MeV gammas over a half life of 10.3 years. Much of the ^{85}Kr currently produced is released to the atmosphere; however, large-scale reprocessing of fuel will require collection of the gas and storage as a waste product. An alternative to storage is utilization, and since the chemical and radiation characteristics of ^{85}Kr make this radionuclide a relatively low hazard from the standpoint of contamination and biological significance, a number of uses have been developed. Tritium is produced as a byproduct of the nuclear-weapons program, and it has a half life of 12.33 years. It has a 0.01861-MeV beta emission and no gamma emission. The absence of a gamma-ray energy eliminates the need for external shielding of the devices utilizing tritium, thus making them easily transportable. Many of the applications require only small quantities of ^{85}Kr or tritium; however, these uses are important to the technology base of the nation. A significant development that has the potential for beneficial utilization of large quantities of ^{85}Kr and of tritium involves their use in the production of low-level lighting devices. Since these lights are free from external fuel supplies, have a long half life (> 10 years), are maintenance-free, reliable, and easily deployed, both military and civilian airfield-lighting applications are being studied.

29284 (DOE/AL/22028—T2) **Specification for strontium-90 500-watt(e) radioisotopic thermoelectric generator. Final report.** Hammel, T.; Himes, J.; Lieberman, A.; McGrew, J.; Owings, D.; Schumann, F. (Teledyne Energy Systems, Timonium, MD (USA)). Apr 1983. Contract AC04-83AL22028. 96p. NTIS, PC A05/MF A01. Order Number DE83011200.

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A conceptual design for a demonstration 500-watt(e) radioisotopic thermoelectric generator has been created for the Department of Energy. The design effort was divided into two tasks, viz., create a design specification for a capsule strength member that utilizes a standard Strontium-90 fluoride-filled WESF inner liner, and create a conceptual design for a 500-watt(e) RTG. Both tasks have been accomplished. The strength-member specification was designed to survive an external pressure of 24,500 psi and meet the requirements of special-form radioisotope heat sources. Therefore the capsule can, if desired, be licensed for domestic and international transport. The design for the RTG features a radioisotopic heat source, an array of nine capsules in a tungsten biological shield, four current-technology series-connected thermoelectric-conversion modules, low-conductivity thermal insulation, and a passive finned-housing radiator for waste-heat dissipation. The preliminary RTG specification formulated previous to contract award has been met or exceeded. The power source will generate the required power for the required service period at 28 volts dc with a conversion efficiency of 8%, provided the existing in-pool capsules at WESF meet the assumed thermal-inventory requirements.

08 HYDROGEN

0801 Production

REFER ALSO TO CITATION(S) 29321, 29332, 30070

29285 (DOE/ER/10971—1) **Study of intermediates from transition metal excited-state electron-transfer reactions. Progress report, August 1, 1981-March 31, 1983.** Hoffman, M.Z. (Boston Univ., MA (USA). Dept. of Chemistry). 31 Mar 1983. Contract AC02-81ER10971. 13p. NTIS, PC A02/MF A01. Order Number DE83009080.

Our work has been directed toward an examination of the behavior of one-electron reduced intermediates that can be generated via excited-state electron-transfer reactions involving transition metal complexes. We have sought to understand the stoichiometry of the formation of the intermediates, their kinetic properties, and the mechanism by which they convert, catalytically or non-catalytically, water to dihydrogen. We have used two general techniques to generate one-electron reduced intermediates: excited-state electron-transfer, and the direct reduction of a substrate using radiation-generated reducing radicals. These techniques have been used in both continuous and pulsed modes, the former for the determination of stoichiometric yields and the latter for the establishment of kinetic parameters. Our particular emphasis has been on the one-electron reduction of $Rh(bpy)_3^{3+}$ and methyl viologen.

29286 (JAERI-M—9724) **Studies on closed-cycle processes for hydrogen production, 5. Progress report for the F.Y. 1980.** Sato, S.; Ikezoe, Y.,; Shimizu, S.; Nakajima, Hayato; Onuki, K.; Suwa, T. (Japan Atomic Energy Research Inst., Tokyo). Oct 1981. 132p. (In Japanese). NTIS (US Sales Only), PC A07/MF A01. Order Number DE83701540.

Studies made in the F.Y. 1980 on the thermochemical and radiation chemical processes for hydrogen production are reported. A hopeful thermochemical process has been studied which contains nickel, iodine and sulfur (NIS process). (1) Amounts of iodine and acid could be titrated in the liquid phase of the ternary system I_2-SO_2-H_2O for further study of this system. (2) Dehydration and decomposition equilibrium pressures of NiI_2 and $NiSO_4$ were measured by Pyrex and quartz Bourdon gages. Decomposition pressures of nickel iodide and sulfate reached 1 atm at 807°C and 878°C. (3) Kinetics of nickel sulfate dehydration and nickel iodide pyrolysis were measured and analysed. The iodide decomposition could be explained as a phase-boundary controlled contracting interface reaction. (4) Sulfur trioxide could by decomposed by Pt and Fe oxide catalysts. In addition, the effect of lowering VHTR temperature to the NIS process was analysed. And a new cycle was studied preliminarily to overcome problems with the NIS process, using methanol as a reactant. Radiolysis of carbon dioxide has been studied as a step for radiation chemical hydrogen production. In the radiolysis, roles of fast and slow back reactions were analysed, and a significant effects of water and carbon monoxide was found.

0802 Storage

REFER ALSO TO CITATION(S) 30024

0808 Properties

REFER ALSO TO CITATION(S) 29916

09 OTHER SYNTHETIC AND NATURAL FUELS

0901 Hydrocarbon Fuels

REFER ALSO TO CITATION(S) 29299, 29301, 29309, 29325, 29326, 29851, 29852, 30056

29287 (DOE/ER/10720—6) Study of Fischer-Tropsch synthesis through the use of surface intermediate scavengers. Progress report, August 1, 1982-April 1, 1983. Ekerdt, J.G. (Texas Univ., Austin (USA)). 1983. Contract AS05-80ER10720. 60p. NTIS, PC A04/MF A01. Order Number DE83010339.

The primary goal of the research is to identify the reaction pathways by which synthesis gas is converted into hydrocarbons. These mechanisms are needed to understand the fundamental causes for selectivity and to develop more selective catalysts from first principles. The actual effort was directed toward studies of Fischer-Tropsch synthesis over Fe/SiO_2 and isosynthesis catalytic chemistry over ZrO_2. Fischer-Tropsch synthesis studies concentrated upon the propagation reaction and the role alkyl species have in propagation and termination. Alkyl species concentrations were inferred by scavenging the alkyl species off the surface during Fischer-Tropsch synthesis. Pyridine was used as the scavenger and C_1-C_4-α-Alkylpyridines were formed. The distributions of the alkylpyridines were studied as a function of the synthesis conditions. These studies established that alkyl fragments are the precursor to gas phase products and that alkyl fragments are participating in the propagation reaction. The details of the propagation reaction, methylene versus CO insertion, could be determined. Isosynthesis studies concentrated upon the reaction pathway to iso-C_4 products and the initiation of the reaction. Rate measurements at 37 atm suggest that isobutene is formed in a stepwise process between a C_3 carbenium ion and a C_1 oxygenaged species. Studies at 1 atm suggest that CO adsorbs and interacts with surface hydroxyl groups to form formates, carbonates and methoxides. The methoxide may be the C_1 species participating in C_4 formation. 9 figures, 6 tables.

29288 (DOE/ER/12058—1) Promoter modifications of catalytic activity and selectivity. Progress report, April 1, 1982-March 31, 1983. Falconer, J.L. (Colorado Univ., Boulder (USA). Dept. of Chemical Engineering). 18 Apr 1983. Contract AC02-82ER12058. 26p. NTIS, PC A02/MF A01. Order Number DE83010916.

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The influence of alkali promoters on CO hydrogenation was studied as a function of catalyst support (Al_2O_3, SiO_2, $SiO_2.Al_2O_3$ and TiO_2). Temperature-programmed reaction was used to study the specific rates of CO and carbon hydrogenation, and temperature-programmed desorption studied the change in H_2 and CO desorption rates. The role of the support was separately studied for comparison. Specific-activity and product distributions were also studied in a differential reactor with gas-chromatography detection. On all catalysts the selectivity for higher hydrocarbons, particularly olefins, was increased by addition of Na or K promoters. On all catalysts but $Ni/SiO_2.Al_2O_3$, however, the specific activity decreased; on $Ni/SiO_2.Al_2O_3$, a slight increase in specific activity was seen. Similarly, significant changes in methanation activation energies were observed for the addition of promoters. Good agreement was obtained between differential reactor studies and temperature-programmed reaction. The role of the promotor is significantly influenced by the oxide support. 12 figures, 4 tables.

0902 Alcohol Fuels

REFER ALSO TO CITATION(S) 29317, 29319, 29320, 29856

29289 (LBL—14220) Ethanol/water, physical and chemical properties for separation-process design. Maiorella, B.; Blanch, H.; Wilke, C. (Lawrence Berkeley Lab., CA (USA)). 1 May 1982. Contract AC03-76SF00098. 203p. NTIS, PC A10/MF A01. Order Number DE83011079.

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Accurate property data are essential for the design and evaluation of new ethanol/water separation processes. Important physical, chemical, and thermodynamic properties of ethanol, water, and their mixtures are compiled here. Property data are also included for major fermentation by-products which can affect the ethanol/water separation design. Data for selected separating agents are also included. The following data are presented: nonideal vapor phase-the fugacity coefficient; liquid specific volumes; vapor pressures and the reference fugacity; vapor/liquid equilibrium; the activity coefficient; thermal properties-vapor and liquid enthalpies; salt effect on ethanol/water equilibrium, and multicomponent equilibrium modeling. (MHR)

29290 (SERI/PR—255-1776) Membrane research subtask, alcohol-fuels program. Annual progress report, FY 1982. Schissel, P. (Solar Energy Research Inst., Golden, CO (USA)). Apr 1983. Contract AC02-77CH00178. 46p. NTIS, PC A03/MF A01. Order Number DE83010324.

A first step toward the evaluation of membranes is to separate ethanol/water mixtures over a range of feed composition, temperature, and pressure. This has been accomplished for an initial set of commercially available membranes using reverse osmosis and pervaporation. Two membrane types (UOP, Inc. RC100 and Film-Tec FT30) have performed well. Under reverse osmosis conditions the trends of product fluxes and separation factors are similar for the two types; however, FT30 is somewhat better in both categories. The flux and separation factors decrease rapidly as the wt % ethanol is increased, and water is always selectively permeated. Fluxes remain at an acceptable level over a wide concentration range; however, the separation factor becomes unacceptably low as the effects of osmotic pressure become predominant (15 to 30 wt % ethanol). This report discusses several methods that can overcome the limitations imposed by osmotic pressure. The present results are compared to published work where polyetheramide and particularly polyacrylamide membranes are identified as excellent performers. Pervaporation apparatus was designed, fabricated, installed, and used to test the membrane set. The vacuum system design was conservative to ensure the maintenance of low, down-stream pressures as required for pervaporation. The RC100 and FT30 membranes also performed well during pervaporation. Each membrane was tested over virtually the complete concentration range, and at both ends of the concentration range each membrane passed the least abundant component preferentially. These results contrast to the reverse osmosis results for these membranes where at low ethanol concentrations water is passed preferentially. The difference in behavior under reverse osmosis and pervaporation conditions disagrees with theoretical implications of one presentation using the solution-diffusion model to compare reverse osmosis and pervaporation.

29291 A general homogeneous catalytic method for the homologation of methanol to ethanol. Chen, M.J.; Feder, H.M.; Rathke, J.W. (Argonne National Lab., IL). *Journal of the American Chemical Society;* **104**: No. 25, 7346-7347(15 Dec 1982).

The direct conversion of synthesis gas to ethanol and the indirect reaction of synthesis gas with methanol to yield ethanol (homologation) have been studied as possible alternative processes for the production of ethanol from coal. Experimental evidence indicates an unusually general catalytic method for methanol homologation occurring in methanol solutions of amines at synthesis gas pressures near 300 atm and temperatures near 200°C. Significantly, methanol is homologated while ethanol is essentially unaffected. In each case, carbon dioxide is the oxygenated byproduct, and ethanol is formed. Since observation of this type of reaction using $Fe(CO)_5$ catalyst, we have become aware of the method's generality extending to several diverse metal centers. This study represents an accumulated detailed knowledge of the mechanism for the iron carbonyl system. More important, however, a clear picture of a common pathway of a number of the complexes has emerged. In general, all of the catalytic reactions use methyl-ammonium ions as methyl carriers, transition-metal complex anions as nucleophilic methyl acceptors, and catalytic decomposition of formic acid to remove protons generated in hydrogen activation steps.

29292 **Thermal conductivity measurements and molecular association in a series of alcohol vapors: methanol, ethanol, isopropanol, and t-butanol.** Frurip, D.J.; Curtiss, L.A.; Blander, M. (Argonne National Lab., IL). *International Journal of Thermophysics;* **2**: No. 2, 115-132(1981).

Thermal conductivity measurements on the vapors of methanol, ethanol, isopropanol, and t-butanol are reported as a function of temperature (330 to 420°K) and pressure 911 to 240 kPa). The thermal conductivity versus pressure isotherms for all four alcohols exhibit upward curvatures at the lower temperatures and nearly linear increases at higher temperatures. This behavior is indicative of a dimeric species and one or more polymeric clusters in the vapor in addition to the monomer. Quantum mechanical calculations have indicated that tetramers are the most likely polymeric species. Detailed analyses of the data provide thermodynamic data ($\Delta H, \Delta S$) for the dimerization and tetramerization reactions and show interesting correlations with the size of the monomer unit.

0903 Inorganic Hydrogen Compound Fuels

REFER ALSO TO CITATION(S) 30010

0904 Solid Waste And Wood Fuels

29293 **Retrofitting existing boilers with solid waste burners.** Desmon, L.G. (Peabody Gordon-Piatt Inc). pp 89-96 of Advances in energy utilities technology. Atlanta, GA; Fairmont Press Inc. (1981).

From 4. world engineering congress; Atlanta, GA, USA (12 Oct 1981).

A telephone survey was conducted to determine which types of industrial plants would generate such waste as could be used to produce energy. Wastes from some of such plants were analyzed chemically and subjected to combustion tests. The test facility is described: the fuel preparation area, the energy exchange area; and instrumentation. Industrial wastes from 5 companies were put through the test. It is concluded that industrial dry composite wastes can be used effectively to replace fossil fuels. Some guidelines are suggested for retrofitting. 0 refs.

13 HYDRO ENERGY

1301 Resources And Availability

29294 **(AD-A—122644/8) Study of the interrelationships between minimum flow release policies and hydroelectric power development in New England. Final report.** (International Engineering Co., Inc., Darien, CT (USA)). Jun 1981. 85p. NTIS, PC A05/MF A01.

This study had three basic objectives, i.e., to determine the range and type of stream flow dimensions being considered for hydroelectric sites in New England; assess the interrelationships between various minimum flow regions; and to identify alternative measures for complying with minimum release requirements while minimizing negative impact upon project feasibility.

1303 Plant Design And Operation

REFER ALSO TO CITATION(S) 29704

29295 **(IDO—10107-Vol.1) Microhydropower handbook. Volume 1.** McKinney, J.D.; Warnick, C.C.; Bradley, B.; Dodds, J.; McLaughlin, T.B.; Miller, C.L.; Sommers, G.L.; Rinehart, B.N. (EG and G Idaho, Inc., Idaho Falls (USA)). Jan 1983. Contract AC07-76ID01570. 428p. NTIS, PC A19/MF A01. Order Number DE83006697.

The purpose of this handbook is to provide a mechanically proficient lay person with sufficient information to evaluate microhydropower site potential, lay out a site, select and install equipment, and finally, operate and maintain the completed system. The actual construction details of the site are not included; rather, pointers are given as to what help he should expect from a construction contractor, and general guidelines on construction details are provided. In addition, information about obtaining financing and permits is provided. To help offset the cost, the person performing the work, referred to as the developer, is encouraged to do as much of the work as possible. However, developers with major areas of uncertainty should consider professional assistance.

29296 **(IDO—10107-Vol.2) Microhydropower handbook. Volume 2.** McKinney, J.D.; Warnick, C.C.; Bradley, B.; Dodds, J.; McLaughlin, T.B.; Miller, C.L.; Rinehart, G.N.; Sommers, G.L. (EG and G Idaho, Inc., Idaho Falls (USA)). Jan 1983. Contract AC07-76ID01570. 408p. NTIS, PC A18/MF A01. Order Number DE83006698.

This volume includes appendices which present technical and economic information in support of the main volume of the Micropower Handbook. Examples are given of the use of this information in designing, constructing and operating, a micro-scale hydro power plant. (LCL)

1305 Economics And Management

REFER ALSO TO CITATION(S) 29295, 29296

29297 **(DOE/EIA—0171(80)) Hydroelectric plant construction cost and annual production expenses - 1980.** (USDOE Energy Information Administration, Washington, DC. Office of Coal, Nuclear, Electric and Alternate Fuels). Mar 1983. 128p. NTIS, PC A07/MF A01. Order Number DE83010828.

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Data for 378 reporting hydroelectric plants in the contiguous United States with an installed capacity of 10 metawatts or greater are detailed. Also covered are 3 plants in Puerto Rico. Federal projects in the US accounted for 46% of the installed capacity of hydroelectric plants and 48% of the hydroelectric generation. Except for TVA, data for federally owned and operated plants are not included in this publication as they were not required to report. As a result, approximately 96 federally owned plants and 28,900 megawatts capacity included in earlier publications are excluded. Therefore, the reader is cautioned against use of these data as statistically representative of any larger universe. Two indexes list names of plants alphabetically by state and alphabetically by plant name. A map of the federal power supply areas and regions is included. A glossary is included.

14 SOLAR ENERGY

1401 Resources And Availability

29298 **Simplified techniques to study components of solar radiation under haze and clouds.** Wesely, M.L. (Argonne National Lab., IL). *Journal of Applied Meteorology;* **21**: No. 3, 373-383(Mar 1982).

Estimates of the global (G), diffuse (D) and direct-beam (I) irradiances at the surface of the earth can be obtained with a single instrument, the "dial" radiometer. The dial assembly intermittently shades a solid-state sensor on a continual automatic basis. This is a very simple instrument that does not require mechanical adjustments of the shade. When corrections for imperfect cosine response and excessive shading of sky radiation are performed, measurements averaged over 1 h should be accurate well within +/- 5%. Estimates of atmospheric turbidity or haziness can be expressed as an extinction coefficient, computed for I in reference to that obtained under cloudless clean skies for the same solar zenith angle. The uneven spectral response of silicon-cell and PAR (photosynthetically active radiation) sensors should be considered when comparing estimates of G, D or I to measurements of these components by a wide-band sensor. Linear relationships seem adequate for a variety of cloud conditions. This allows the use of a single dial silicon-cell radiometer, for example, to estimate quite accurately the values of G, D and I that would be seen by wide-band PAR radiometers. An alternative, but less exact, means of obtaining estimates of hourly averages of D and I is to measure only G and use the ratio of G to

that which would be obtained under clean, cloudless conditions as the sole determining factor.

1403 Economics

REFER ALSO TO CITATION(S) 29319, 29337, 29348, 29349

1404 Environmental, Legal, And Institutional Aspects

REFER ALSO TO CITATION(S) 29398, 29399, 29400, 29401, 29403, 29407

1405 Solar Energy Conversion

REFER ALSO TO CITATION(S) 29285, 29289, 29290, 29790, 29792, 29793, 29829, 29851, 29852, 30061, 30407, 30440

29299 **(BNL—32746) Flash pyrolysis of biomass with reactive and non-reactive gases. Summary report, March 1982-March 1983.** Steinberg, M.; Fallon, P.T.; Sundaram, M.S. (Brookhaven National Lab., Upton, NY (USA)). Mar 1983. Contract AC02-76CH00016. 25p. (CONF-830323—2). NTIS, PC A02/MF A01. Order Number DE83010852.

From 15. biomass thermochemical conversion contractors' meeting; Atlanta, GA, USA (16 Mar 1983).

The process chemistry of the flash pyrolysis of biomass (wood) with the reactive gases, H_2 and CH_4 and with the non-reactive gas He is being determined in a 1" downflow tubular reactor at pressures from 20 to 1000 psi and temperatures from 600 to 1000°C. With hydrogen, flash hydropyrolysis leads to high yields of methane and CO which can be used for SNG and methanol production. With methane, flash methanolysis of wood, leads to high yields of ethylene, benzene and CO which can be used for the production of valuable feedstocks and methanol fuel. At reactor conditions of 50 psi and 1000°C and approximately 1 sec residence time, the ethylene yield based on wood carbon converted is 22%, benzene 12% and the CO yield is 48%. The yield of ethylene is 2.2 times higher with methane than with helium, thus indicating a free radical rection between CH_4 and the pyrolyzed wood. A preliminary process analysis indicates an economically competitive process for the production of ethylene, benzene and methanol based on the methanolysis of wood. It is recommended to further develop the data base for the flash pyrolysis of wood and other biomass materials with methane as well as with other reactive gases (e.g. CO and CO_2) and determine the role of the hemi-cellulose and lignin in the formation of these valuable fuels and feedstocks.

29300 (CONF-810622—Vol.1, pp 249-252) **Biomass production in oceanic settings: a progress report.** North, W.J. (California Inst. of Tech., Pasadena, CA). Jun 1981. NTIS, PC A24.

From 8. ocean energy conference; Washington, DC, USA (7 Jun 1981).

Research on biomass production in oceanic waters has been actively underway since 1973. Objective is to assess feasibility of marine biomass production as an alternative energy source. Our basic plan has involved use of giant kelp, Macrocystis, as the experimental organism. Macrocystis would be cultured on moored or drifting structures in the open sea, and the harvested biomass would be converted to methane by bacterial digestion. Technical feasibility of the concept seems fairly soundly established as a result of our studies, and we are presently evaluating economic feasibility. Principal uncertainties are associated with enhancing kelp cultivation. Very high yields will probably be required to assure economic feasibility. We are presently involved in assessing the proper combination of culturing conditions that will maximize yield.

29301 **(DOE/CS/40202—T6) Conversion of cellulosic wastes to liquid fuels.** Kuester, J.L. (Arizona State Univ., Tempe (USA). Coll. of Engineering and Applied Sciences). Aug 1982. Contract AC02-76CS40202. 118p. (COO—2982-83). NTIS, PC A06/MF A01. Order Number DE83007978.

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A project to convert various cellulosic materials to quality liquid hydrocarbon transportation fuels is described. The major accomplishment was achieving projected liquid hydrocarbon yields of 30 to 40 gals/ton of cellulosic feedstock (dry, ash free) for synthesis gas compositions corresponding to that obtainable for average feedstocks and using relatively inexpensive cobalt/alumina type impregnated catalysts. The utility of using dolomite to adjust the H_2/CO pyrolysis gas ratio was demonstrated. An iron liquefaction catalyst study was completed that confirmed the detriment of olefins in the feedgas for these type of catalysts (as opposed to cobalt based catalysts. Two completely new fluidized bed reactor systems were designed and installed to accommodate the liquefaction catalyst development work. An extensive simulator study on gasification transfer loop systems resulted in recommendations for system improvements. Modifications of the 6" fluidized bed liquefaction reactor were also started based on simulator work.

29302 **(DOE/ET/20000—T5) Biological investigations of marine farms. Final report, July 1, 1976-December 31, 1979.** (California Inst. of Tech., Pasadena (USA)). Jan 1983. Contract AC03-76ET20000. 297p. NTIS, PC A13/MF A01. Order Number DE83007591.

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Activities of the marine farm project from 1976 to 1979 are described. The group was concerned with biomass production. Problems such as species selection, optimal plant nutrition, and maintaining a crop at sea under simulated oceanic conditions were addressed. Overall objective of the project was to investigate feasibility of biomass production in the oceanic environment, as an alternative energy source. Project support from the gas industry caused our primary focus to be directed towards methane production.

29303 **(DOE/ET/20254—T1) Indium phosphide/cadmium sulfide thin-film terrestrial solar cells. Final report, 1 September 1976-30 November 1978.** Zanio, K.; Fraas, L. (Hughes Research Labs., Malibu, CA (USA)). Dec 1978. Contract AC04-76ET20254. 74p. NTIS, PC A04/MF A01. Order Number DE83009684.

The planar reactive deposition (PRD) technique was developed as a practical low-temperature technique for depositing thin films of InP. Indium phosphide was epitaxially deposited onto InP and CdS single-crystal substrates in the 320 to 420°C temperature range. Undoped films deposited on semi-insulating substrates are n-type with room-temperature mobilities as high as 4062 $cm^2/Vsec$, corresponding to a residual active impurity concentration of a few times 10^{16} cm^{-3}. InP was also deposited onto polycrystalline thin films of CdS. Depletion of Cd from the thin films restricts the InP-on-CdS-on-glass all-thin-film solar cell concept to processing temperatures below 350°C. The quality of the InP thin films made by our PRD process and their suitability as layers in thin-film solar cells was established by comparing CdS-on-InP solar cells made with our intermediate PRD InP layers with cells made only with commercial InP single-crystal substrates. To this effect, single-crystal CdS-on-InP cells were prepared by depositing CdS onto single crystals of commercial p-type InP (reference cells) and onto intermediate micrometer-thick layers of Be-doped p-type InP, the latter deposited earlier onto the commercial InP substrates over the 320 to 400°C range by the PRD approach. The efficiency of the best reference cells and the best cells using the intermediate PRD thin films as the light-absorbing layer were both approximately 10% (air mass 2 illumination with no antireflection coating). Cell efficiency was not found to depend on the temperature of preparation of the intermediate single-crystal PRD layer.

29304 **(DOE/JPL/955506—83-3) Ion-plating of solar-cell arrays encapsulation task: LSA Project 32. Final report.** Volkers, J.C. (Illinois Tool Works, Inc., Elgin (USA). Venture Group). [nd]. Contract NAS-7-100-955506. 36p. NTIS, PC A03/MF A01. Order Number DE83010194.

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The work reported was to investigate, develop and demonstrate the capability to produce operational solar cells having metallizations and anti-reflective (AR) coatings deposited by gasless ion plating, which will separately and/or in combination with a low-cost encapsulation system, meet the LSA project life, cost and performance goals. The capability to produce operational solar cells, both N on P and P on N types, with ion plated metallizations has

been developed. Further, the ability to deposit AR coatings by ion plating has been demonstrated. The performance characteristics of solar cells thus produced has been equal to that of control cells finished with conventional metallization systems. Additionally, SAMICS analysis have shown that such process can meet cost requirements. Although life tests have not been performed, corrosion tests which have been performed imply that solar cells with ion plated metallization and AR coating will be much less susceptible to corrosion of the electrodes than will solar cells with conventional metallizations and AR coatings.

29305 **(DOE/JPL/955676—4) Analysis of defect structure in silicon: characterization of Semix material. Silicon sheet growth development for the Large Area Silicon Sheet Task of the Low-Cost Solar Array Project. Final report.** Natesh, R.; Stringfellow, G.B.; Virkar, A.V.; Dunn, J.; Guyer, T. (Materials Research, Inc., Centerville, UT (USA)). Feb 1983. Contract NAS-7-100-955676. 137p. NTIS, PC A07/MF A01. Order Number DE83009983.

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Statistically significant quantitative structural imperfection measurements were made on samples from a Ubiquitous Crystalline Process (UCP) Ingot. Important correlation was obtained between defect densities, cell efficiency, and diffusion length. Grain boundary substructure displayed a strong influence on the conversion efficiency of solar cells from Semix material. Quantitative microscopy (QTM) measurements gave statistically significant information compared to other micro-analytical techniques. A surface preparation technique to obtain proper contrast of structural defects suitable for QTM analysis was perfected and is now being used routinely. A study was made to determine the relationships between hole mobility and grain boundary density. Mobility was measured using the van der Pauw technique, and grain boundary density was measured using quantitative microscopy technique. Mobility was found to decrease with increasing grain boundary density.

29306 **(DOE/JPL/955843—83/9) Large-area sheet task: advanced dendritic web growth development. Quarterly report, October 23, 1982-December 31, 1982.** Duncan, C.S.; Seidenstickler, R.G.; McHugh, J.P. (Westinghouse Research and Development Center, Pittsburgh, PA (USA)). 22 Mar 1983. Contract NAS-7-100-955843. 31p. NTIS, PC A03/MF A01. Order Number DE83011050.

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The thermal stress models were used to test the effect of melt level on stress generation and growth velocity. The results indicate that melt level has only small effects on stresses but significant effects on growth velocity. These results are consistent with experimental growth from measured melt levels. A new low-stress design concept is being evaluated with the models. A width-limiting version of the low-stress J460 configuration was tested experimentally with results consistent with the design goals.

29307 **(DOE/JPL/955902—82/6) Process research on polycrystalline-silicon material (PROPSM). Quarterly report No. 6, March 1-June 30, 1982.** Wohlgemuth, J.H.; Culik, J. (Solarex Corp., Rockville, MD (USA)). 1982. Contract NAS-7-100-955902. 19p. NTIS, PC A02/MF A01. Order Number DE83009855.

The emphasis of the program described is the investigation of polycrystalline silicon to determine the mechanisms affecting conversion efficiency and the development of processes that take full advantage of its potential as a photovoltaic material. The technical program plans are described. The first task is to determine the mechanisms limiting performance in polycrystalline silicon. The initial set of experiments in this task entails the fabrication of cells of various thicknesses and bulk resistivities. Results for two lots are given. Another experiment planned is the processing of polycrystalline wafers into samples containing isolated mini-cells and measuring their performance. Another task planned will investigate process developments that are likely to aid cell efficiencies. (LEW)

29308 **(DOE/JPL/956205—83/3) Development of metallization process: FSA project, cell and module formation research area. Quarterly technical progress report for the period ending December 31, 1982.** Garcia, A. III. (Spectrolab, Inc., Sylmar, CA (USA)). Apr 1983. Contract NAS-7-100-956205. 11p. NTIS, PC A02/MF A01. Order Number DE83011221.

Solar cells have been produced using a Mo/Sn/TiH screen printed paste with a lead/borosilicate frit that are electrically comparable to control silver cells. The process is currently unsuccessful because the soldering of interconnects to these cells has proved difficult. Future work will investigate using CO instead of H_2 as the reducing gas and putting an ITO coating on the cell prior to metallization.

29309 **(DOE/R5/10329—2) Rapid methane generation from solid waste. Final project report.** (Snell Environmental Group, Inc., Lansing, MI (USA)). Jan 1983. Contract FG02-81R510329. 70p. NTIS, PC A04/MF A01. Order Number DE83010988.

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The investigation consisted of assessing on a bench scale, the efficiency of a two-stage digester designed to produce methane from municipal refuse. The first stage of the digester which contained the refuse was used to produce volatile acids. The second stage which contained no refuse was used to optimize the volatile acid concentration for methane production by cycling volatile acids from Stage I to Stage II. In this study it was verified that the two most important control parameters for methane production are volatile acid concentration and pH. Furthermore, it was found that as liquid is cycled from Stage I to Stage II and back, Stage I becomes the primary methane producer. Overall it was demonstrated that the two stage system is an efficient and potentially economical approach to methane production.

29310 **(EUR—8197-EN) Recrystallization of amorphous and small-grain-size polycrystalline silicon. Final report, July 1979-July 1980.** Schins, W.J.J.; Bezemer, J.; Ouwens, C.D.; Radelaar, S. (Rijksuniversiteit Utrecht (Netherlands). Fysisch Lab.). 1982. 52p. European Communities Information Service, 2100 M Street NW, Suite 707, Washington, DC 20037.

The influence of Al and B dopants on the recrystallization and grain growth of polysilicon layers on graphite and SiO_2 is examined. A study is reported concerning the deformation and recrystallization of polycrystalline silicon. Results are reported on the quality of Schottky barrier, MIS, and p-n junction solar cells. (LEW)

29311 **(EUR—8198-EN) Thin-film amorphous silicon solar cells.** Holwill, R.J.; McGill, J.; Riddoch, F.; Robinson, P.; Smith, S.D.; Wallace, A.; Weaire, D.L.; Wilson, J.I.B. (SEE CODE- 9698758 Heriot-Watt Univ., Edinburgh (UK). Dept. of Physics). 1982. 49p. European Community Information Service, 2100 M Street, N.W., Suite 707, Washington, DC 20037.

MIS Solar cells with the structure Ni/TiO/sub x//undoped amorphous silicon/n^+ amorphous silicon/stainless steel have given AM1 power conversion efficiencies of almost 5% for small devices and over 2% for 1 cm^2 devices. The relative importance of substrate temperature, silane pressure and flow rate, and rf power have been examined by studying the optical and electrical properties of glow discharge silicon films. Two hundred films have been prepared for this project by our continuous-flow rig. The hydrogen content, bonding, and stability have been studied by infrared spectroscopy and thermal effusion. Films can now be made which contain less than 10% of hydrogen in Si-H groups and not in $Si-H_2$ groups. A model structure for hydrogenated amorphous silicon has been constructed, which showed the ease with which hydrogen clusters are incorporated. The density of the model was in good agreement with reported experimental values. The optical constants (refractive index and absorption coefficient) have been measured of films grown under various conditions, and were especially sensitive to substrate temperature. The maximum electrical conductivity which was achieved in phosphine-doped films was 1.75×10^{-2} (Ω

cm)$^{-1}$. Both PH_3/Ar and PH_3/H_2 gave identical results. The conductivity activation energy lay between 0.21 and 0.72 eV. The effect of an evaporated interfacial TiO/sub x/ layer on the dark and illuminated characteristics of Ni-contacted diodes was shown. Both effective barrier height and ideality factor were illumination dependent. The optimum thickness of the heavily-doped layer adjacent to the substrate was determined, and its influence on cell resistance losses was shown. The influence of doping level on the photo-voltage was shown for gold-Schottky contacts. Cell spectral response curves were measured and calculated, and were consistent with a space charge width (i.e. collection width) of 0.15 μm.

29312 **(EUR—8200-EN) Development of a 1-pkW photovoltaic concentrator system with silicon cells. Final report, January 1978-Decembr 1979.** Giuffrida, M.; Oberti, A.; Zani, P.; Dionisio, G.; Ramacciotti, G.; Scarpi, G.; Conti, M.; Nason, P. (Montedison S.p.A., Novara (Italy). Ist. di Ricerche G. Donegani; Ansaldo S.p.A., Genoa (Italy); Officine Galileo S.p.A., Florence (Italy); SGS/ATES Componenti Elettronici S.p.A., Milan (Italy)). 1982. 44p. European Communities Information Service, 2100 M Street NW, Suite 707, Washington, DC 20037.

The objective of the work reported was to design, construct, and preliminarily test a 1 kW photovoltaic unit with concentration (50 X), passive cooling, and silicon cells. Tasks completed include: assessment of the design of the prototype of the concentration system, development of the cells and performance testing under illuminations comparable with practical levels, and construction and testing of the structure. (LEW)

29313 **(EUR—8202-EN) Development of low-cost cadmium sulfide sintered ceramic-ribbon solar cells for terrestrial applications.** Barber, V.; Gray, D.R.; Smart, M.G.; Norgate, P.; Yick, P. (Heliodyne Ltd., Crawley, West Sussex (UK)). 1982. 80p. European Community Information Service, 2100 M Street, NW, Suite 707, Washington, DC 20037.

The purpose of the program was the further development of the basic production processes for the preparation of low cost cadmium sulfide sintered ceramic solar cells for terrestrial use. The main objectives of the present program were: (1) the continued investigation into the preparation of CdS type powders adapted to the use of thin layers of CdS; (2) to adapt the existing know how to produce thinner cells, of say 25 to 50 cm², ideally formed directly onto a backing electrode; (3) to investigate the semi-continuous production of n type CdS/backing layer ribbon or sheet suitable for the production of large CdS solar cells; and (4) to investigate semi-continuous heterojunction formation on the n type CdS. The early phases of the program concentrated on improving the methods used to produce single circular solar cells together with new work on improving the production methods for laboratory CdS. Subsequently, with the availability of larger quantities of CdS, the feasibility of producing CdS ribbon in a roller press was examined. In parallel with this a series of backing electrode materials were also examined. Such materials were expected to provide both electrical contact to the CdS layer and to provide a mechanical support for the solar cell. Since photovoltaic grade CdS is a relatively expensive commodity the use of a cheap backing material was expected to considerably reduce the cost of the sintered ceramic CdS solar cell.

29314 **(EUR—8205-EN) Ion implantation of glow-discharge amorphous silicon and possible application to solar-cell devices. Final report.** (Dundee Univ. (UK). Carnegie Lab. of Physics; Max-Planck-Institut fuer Kernphysik, Heidelberg (Germany, F.R.)). 1982. 71p. European Community Information Service, 2100 M Street, N.W., Suite 707, Washington, DC 20037.

The main objectives of the work carried out were (a) to investigate in some detail the doping of a-Si by ion implantation, (b) to optimize the technique, (c) to study and improve material properties using nuclear and other techniques of measurement and (d) to assess the application of ion implantation to a-Si photovoltaic junction cells. It was shown in a systematic study of implantation with trivalent, pentavalent and alkali ions, that a-Si can be doped substitutionally as well as interstitially, and that its electrical properties can be controlled over a remarkably wide range. Compensation by implantation is possible and can be used in junction devices. Implantation damage and its effects on the properties of a-Si have been investigated by photoconductivity and other methods. A nuclear resonance reaction was used to determine the hydrogen profile through the a-Si film and it was concluded that this could be a useful method for investigating the barrier profile in a-Si devices. A series of preliminary experiments on a-Si solar cells with implanted top p^+-regions was carried out during the third contract year. Results using an implantation depth of 1000A were encouraging, but showed that for an improved V/sub oc/ appreciably smaller depths are essential. Finally, the main conclusions of the work are summarized.

29315 **(EUR—8211-EN) Two-dimensional aspects of thin-film solar cells.** Pauwels, H.J.; De Visschere, P.; Vandendriessche, L. (Ghent Rijksuniversiteit (Belgium). Lab. voor Elektronica en Meettechniek). 1982. 68p. European Community Information Service, 2100 M. Street, N.W., Suite 707, Washington, DC 20037.

The purpose of this project was to investigate the two-dimensional aspects of MIS solar cells. In the literature only one-dimensional models, emphasizing the interface properties, are described, while in practice the structures are indeed two-dimensional. Especially two types of MIS solar cells must be considered: thin film MIS solar cells with a transparent front electrode where the two-dimensional character is due to the irregular thickness of the insulating layer and the MIS inversion layer solar cells. A two-dimensional mathematical model has been developed for these cells and for the MIS inversion layer solar cell this has resulted in a computer program for calculating the IV-characteristic. The model is based essentially on the abrupt space charge layer and the gradual channel approximation. By using these, the problem is reduced to solving the classical diffusion equation in the bulk of the semiconductor, together with the appropriate boundary conditions. The transport properties of the space charge layer are incorporated in a non linear boundary condition. The mathematical problem is solved using a Boundary Element Method, which is applicated iteratively. It has been found that in addition to the light generated carriers that diffuse directly towards the contact figures, a major part of the carriers are collected along the space charge layer below the insulator, except for high bias voltages. The influence of the oxide charge density on the collection efficiency has been investigated. This makes it possible to determine an optimum finger spacing.

29316 **(FRNC-TH—1086) Contribution to the study and optimization of pulverized Cu_2S-CdS photocells (CdS optical window).** Perotin, M. (Montpellier-2 Univ., 34 (France)). Jul 1981. 265p. (In French). NTIS (US Sales Only), MF A01. Order Number DE83750439.

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A part of the work is devoted to the study of the fabrication process of the optical and electric properties of the three thin layers forming the cell: tin doped indium oxide, better known as ITO, cadmium sulphur and copper sulphur. The photovoltaic results achieved on the pilot system are described, highlighting the change observed during the modifications made to the fabrication parameters and leading to the present mean and optimal results (n = 6%; nsub(max) = 7.4%). These are then followed by the experimental results concerning the current-voltage determinations in obscurity and with the intensity of light, the measurements of capacity and the spectral responses for the three types of fabrication. An interpretation of the evolution of experimental results is given, on the basis of the changes brought about in the fabrication. An evaluation of the in-series resistance of the cell is then made followed by an interpretation of the variation of the parameters of the Is and "a" conduction under light. The photo-voltage achieved is less than expected. An endeavour is made to explain the various origins of this weakness

29317 **(LBL—15752) Vacuum ethanol distillation technology.** Maiorella, B.L.; Blanch, H.W.; Wilke, C.R. (Lawrence Berkeley Lab., CA (USA)). Mar 1983. Contract AC03-76SF00098. 166p. NTIS, PC A08/MF A01. Order Number DE83011082.

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The design principles for one particularly efficient distillation arrangement employing available technology are illustrated. The newly developed temperature dependent UNIQUAC vapor/liquid equilibrium computation methods are utilized in the design of a minimum cost distillation plant for the production of 100 million liters per year of 95 wt % ethanol product. Vacuum distillation and vapor reuse methods are employed. These methods combine synergistically to reduce the distillation energy requirement in concentrating dilute beer feeds. The vapor reuse methods are then extended to demonstrate how 99.9 wt % ethanol are then produced at virtually no additional energy cost.

29318 **(NYSERDA—82-16) Case history development of a hybrid poplar nursery at Reynolds Metals Company, Massena, NY. Final report.** Marler, R.L. (Marler (R.L.), White Stone, VA (USA)). Mar 1983. 26p. New York State Energy Research and Development Authority, Two Rockefeller Plaza, New York, NY 12223.

The methods used to establish the hybrid poplar nursery and the results obtained in the first year's operation are discussed. It also documents the history of the project. Hybrid poplar clones were established in the nursery in 1980 and their growth performance was evaluated after one growing season. The results were most promising. The mean survivability rate ranged from 84.92% to 90.58% per clone, while the clone height growth ranged from 58.16 inches to 76.47 inches over the first growing season. Approximately 71,000 cuttings were estimated to be available for outplanting during the Spring of 1982.

29319 **(NZERDC—82) Contract arrangements for feedstock supply for energy farming. Final report.** Lough, R.D.; Brown, W.A.N. (New Zealand Energy Research and Development Committee, Auckland). Aug 1982. 45p. NTIS (US Sales Only), PC A03/MF A01. Order Number DE83901603.

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The existing supply agreements operating in New Zealand agriculture are reviewed and the format and conditions of relevant overseas contracts assessed. Options for the framework for a feedstock supply agreement in New Zealand are discussed. The major factors influencing the components of the particular supply agreement are outlined.

29320 **(NZERDC—83) Production and use of butanol-acetone as liquid fuel.** (New Zealand Energy Research and Development Committee, Auckland). Aug 1982. 32p. NTIS (US Sales Only), PC A03/MF A01. Order Number DE83901602.

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n-butanol, acetone and ethanol (ABE) can be used as fuels in internal combustion engines with minimal blending or distributional problems. The bacterial fermentation of agricultural feedstocks to make ABE is a process made obsolete by cheap oil. The production costs of ABE by fermentation to determine economic incentives to resuscitate the technology to generate substitute fuels in this country were reviewed. Three designs were executed: Case 1. Production of ABE from 200 oven dried tonnes per day of beet feed using distillation recovery. Case 2. The same plant as Case 1 adapted to utilize recovery of ABE by liquid-liquid extraction as far as practicable. Case 3. On-farm production of n-butanol only to make 30,000 litres per annum from maize feedstock. Cases 1 and 2 are calculated on the basis of actual practicing fermentation technology combined with a modern approach to product extraction. Some national technological developments were assumed in Case 3 to make it a practical proposition. The cost of production of ABE in Case 1 is not less than 53 cents per litre. This figure does not include cost of delivered feedstock or of the other site-specific expenses such as land purchase and development, effluent disposal, etc. Capital costs are calculated at 3rd qr. 1981 prices. It seems improbable that the ABE fermentation process can be made sufficiently efficient to become the means of manufacturing substitute fuels on a national scale in the near future.

29321 **(ORNL/TM—8628) Photosynthetic water splitting. Annual report, November 1, 1981-October 31, 1982.** Greenbaum, E. (Oak Ridge National Lab., TN (USA)). Dec 1982. Contract W-7405-ENG-26. 35p. (GRI—82-0033). NTIS, PC A03/MF A01. Order Number DE83010386.

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The first measurements of the simultaneous photoproduction of hydrogen and oxygen in marine green algae have been performed. Eight species in the general Chlamydomonas, Chlorella, and Halochlorocococcum were tested in CO_2-free sea water. Four of the five species of Chlamydomonas were able to produce hydrogen in the light after a period of 3 to 4 h of dark anaerobic adaptation. Only one of the two Chlorella species tested was able to photoproduce hydrogen - in trace amounts. Halochlorocococcum fla-9 gave positive results, and Chlamydomonas species (clone f-9) had a steady-state rate of hydrogen and oxygen production during irradiation with a stoichiometric ratio near 2:1. The integrated yields of hydrogen and oxygen produced by this species correspond to about 450 turnovers of the photochemical reaction centers. This number exceeds (by about a factor of 20) the electron-carrying capacity of the electron transport chain linking Photosystems I and II. These data suggest that Chlamydomonas f-9 makes sea water a potential substrate for solar hydrogen and oxygen production.

29322 **(SAND—81-0135-Rev.2) Bibliography of reports by the Sandia Photovoltaic Projects.** Burgess, E.L. (ed.). (Sandia National Labs., Albuquerque, NM (USA)). Mar 1983. Contract AC04-76DP00789. 65p. NTIS, PC A04/MF A01. Order Number DE83010182.

Reports are listed that are concerned with: photovoltaic systems definition and development, photovoltaic concentrator technology, and photovoltaic system application experiments. Reports are listed in chronological order, by principal author, and by report number. (LEW)

29323 **(SAND—82-7125) Novel approaches for low-cost photovoltaic concentrator. Final report, January 1978-July 1980.** Muller, T.; Maraschin, R. (Acurex Corp., Mountain View, CA (USA)). Nov 1982. Contract AC04-76DP00789. 162p. NTIS MF A01. Order Number DE83010297.

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A concept has been developed for a photovoltaic concentrator that uses sealed beam headlight technology. The photovoltaic cell is placed at the focus of the headlamp reflector. A prototype 60 W array was designed, built, and tested. Array efficiency was approximately 6%.

29324 (SERI/CP—234-1577, pp 99-107) **Efficiency of solar energy conversion: a comparative analysis of thermal and quantum conversion processes.** Haught, A.F. (United Technologies Research Center, East Hartford, CT). 1981. NTIS, PC A11/MF A01.

From Thermo regenerative electrochemical systems workshop; Alexandria, VA, USA (3 Dec 1981).

In considering solar energy conversion there is a widespread and persistent conviction that the most efficient approach involves utilization of the radiation in full photon chunks as in a photovoltaic or photochemical system. Since the radiation is absorbed in 1-2 eV photon elements, it is argued, upon reversal of the absorption reaction the photon energy is recovered and the efficiency can be quite large. This view is in general incorrect, and the general problem of radiation conversion, which has significant implications for thermally regenerative electrochemical systems for solar applications, is addressed. Carnot addressed the problem, with what efficiency can heat available at a given temperature be converted to useful work. The analogous problem, with what efficiency can radiation of a given intensity and frequency spectrum be converted to useful work, is addressed and the results are applied to the particular case of solar energy conversion.

29325 (SERI/PR—234-1883) Ablative pyrolysis of biomass in the entrained-flow cyclonic reactor at SERI. Annual report, 1 October 1981-30 November 1982. Diebold, J.; Scahill, J. (Solar Energy Research Inst., Golden, CO (USA)). Jan 1983. Contract AC02-77CH00178. 119p. NTIS, PC A06/MF A01. Order Number DE83011190.

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Progress with the entrained-flow cyclonic reactor at SERI is detailed. Feed-stocks successfully used include wood flour and fairly large sawdust. Preliminary results show that relatively complete vaporization of the biomass is realized and that the yields of tar or gas can be varied over quite a range with trends following first-order kinetics. The effect of the ratio of steam to biomass was investigated and found to be minor compared to cracking severity.

29326 (SERI/PR—234-1884) Fundamental pyrolysis studies. Annual report FY 1982. Milne, T.A.; Soltys, M.N. (Solar Energy Research Inst., Golden, CO (USA)). Apr 1983. Contract AC02-77CH00178. 41p. NTIS, PC A03/MF A01. Order Number DE83010440.

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Progress on the direct mass spectrometric sampling of pyrolysis products from wood and its constituents is described for FY 83. A brief summary, and references to detailed reports, of the qualitative demonstration of our approach to the study of the separated processes of primary and secondary pyrolysis is presented. Improvements and additions to the pyrolysis and data acquisition systems are discussed and typical results shown. Chief of these are a heated-grid pyrolysis system for controlled primary pyrolysis and a sheathed-flame arrangement for secondary cracking studies. Qualitative results of the secondary cracking of cellulose, lignin, and wood are shown as are comparisons with the literature for the pyrolysis spectra of cellulose, lignin, and levoglucosan.

29327 (SERI/TP—231-1929) Optimizing multiproduct conversion processes for commercial use: the case of microalgae production. Hill, A.; Neenan, B. (Solar Energy Research Inst., Golden, CO (USA)). Mar 1983. Contract AC02-77CH00178. 7p. (CONF-830435—1). NTIS, PC A02/MF A01. Order Number DE83010217.

From Annual meeting of the American Solar Energy Society; Minneapolis, MN, USA (1 Apr 1983).

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Large-scale production of microalgae offers promise for renewable production of a wide variety of high-value fuels and chemicals currently derived from petroleum and natural gas feedstocks. Microalgae-derived products include processing and extraction products (protein, fatty acids), catalytic conversion products (parafins, olefins), and fermentation products (ethanol, methanol). Commercial acceptance of microalgal technology depends on the development of economical conversion technologies. The identification of such processes involves the evaluation of the trade-off between costs associated with control of physical and biological parameters and the ability of the production facility to change system operations (e.g., change the product slate) in response to changes in market conditions.

29328 (SERI/TR—9-8309-1-T8) Cadmium sulfide/copper sulfide heterojunction cell research. Volume I. Final report, September 1, 1979-March 15, 1982. Birkmire, R.W.; Hall, R.B.; Phillips, J.E. (Delaware Univ., Newark (USA). Inst. of Energy Conversion). Feb 1983. Contract AC02-77CH00178. 91p. NTIS, PC A05/MF A01. Order Number DE83010013.

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Thin-film Cu_xS/(CdZn)S solar cells have been made with a conversion efficiency of over 10% in actual sunlight testing. A reliable laboratory scale procedure has been developed for producing cells of this type. A technique has been developed for laser scanning ungridded cell material to locate the defects responsible for electrolytic decomposition of the Cu_xS and the associated loss in cell output. Improved production procedures were developed to reduce by orders of magnitude the number of such defects. Remaining defects have been neutralized using a laser pulse technique. Defect-free Cu_xS/CdS material has been shown to be stable under continuous illumination at open-circuit voltage for periods in excess of 500 hours. A procedure for depositing compound semiconductors such as (CdZn)S has been developed utilizing temperature controlled elemental sources. The technique has also been applied to $CuInSe_2$.

29329 (SERI/TR—8021-1-T1) Cadmium sulfide/copper ternary heterojunction cell research. Final report, April 1, 1980-August 25, 1982. Mickelsen, R.A.; Chen, W.S. (Boeing Aerospace Co., Seattle, WA (USA)). Aug 1982. Contract AC02-77CH00178. 110p. NTIS, PC A06/MF A01. Order Number DE83000997.

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The properties of polycrystalline, thin-film $CuInSe_2$/CdS and $CuInSe_2$/Zn/sub x/Cd/sub 1-x/S solar cells prepared by vacuum-evaporation techniques onto metallized-alumina substrates are described. An efficiency of 10.6% for a 1 cm^2 area cell and 8.3% for an 8 cm^2 cell when tested under simulated AM1 illumination is reported. The mixed-sulfide cells are described as exhibiting increased open-circuit voltages, slightly higher short-circuit currents, and improved efficiencies. Mixed-sulfide film preparation by evaporation of CdS and ZnS powders from a single source and from two sources is discussed with preference given to the later technique. Selenide-film preparation in a planetary or rotating substrate vacuum-deposition apparatus is described. A 1 cm^2 area cell without AR-coating produced by the planetary approach is reported to demonstrate a 7.5% efficiency. The results of cell heat-treatment studies showing a strong environmental dependence are presented and indicate the desirability of an oxygen-containing atmosphere. An automatic, computer-controlled, cell-measurement system for I-V, C-V, and spectral-response analysis is described. The results of the cell-analysis and cell-modeling studies on both the plain CdS and mixed Zn/sub x/Cd/sub 1-x/S thin-film devices are presented. Finally, data obtained from constant illumination and elevated temperature life-tests on the thin-film cells showing little degradation after 9300 hours is reported.

29330 Formation of aromatic compounds from condensation reactions of cellulose degradation products. Russell, J.A.; Miller, R.K.; Molton, P.M. (Pacific Northwest Lab., Richland, WA). *Biomass;* 3: No. 1, 43-57(1983). Contract AC06-76RL01830.

This research was undertaken to understand the formation of aromatic compounds when cellulose is liquefied in an aqueous alkaline environment. Work done by other authors shows that low molecular weight weight aldehydes and ketones can form aromatic compounds via condensation reactions under a variety of reaction conditions. Selected aldehydes and ketones which might have formed from cellulose degradation were reacted under cellulose liquefaction conditions. Many of the same aromatic compounds were formed from these reactions as were found in cellulose derived oils. Although the exact mechanisms may in some cases be complex, the condensation and cyclisation of these aldehydes and ketones is apparently involved in the formation of aromatic compounds in cellulose liquefaction oils. 6 figures, 3 tables.

29331 High-efficiency photovoltaic cells. Yang, H.T.; Zehr, S.W. US Patent Application 6-390,731. 21 Jun 1982. 32p. Contract AC02-77CH00178.

High efficiency solar converters comprised of a two cell, non-lattice matched, monolithic stacked semiconductor configuration using optimum pairs of cells having bandgaps in the range 1.6 to 1.7 eV and 0.95 to 1.1 eV, and a method of fabrication thereof, are disclosed. The high band gap subcells are fabricated using metal organic chemical vapor deposition (MOCVD), liquid phase epitaxy (LPE) or molecular beam epitaxy (MBE) to produce the required AlGaAs layers of optimized composition, thickness and doping to produce high performance, heteroface homojunction devices. The low bandgap subcells are similarly fabricated from AlGa(As)Sb compositions by LPE, MBE or MOCVD. These subcells are then coupled to form a monolithic structure by an appropriate bonding technique which also forms the required transparent intercell ohmic contact (IOC) between the two subcells. Improved ohmic contacts to the high bandgap semiconductor structure can be formed by vacuum evaporating to suitable metal or semiconductor materials

which react during laser annealing to form a low bandgap semiconductor which provides a low contact resistance structure.

29332 Method for producing hydrogen and oxygen by use of algae. Greenbaum, E. US Patent Application 6-388,872. 16 Jun 1982. 13p. Contract W-7405-ENG-26.

Efficiency of process for producing H_2 by subjecting algae in an aqueous phase to light irradiation is increased by culturing algae which has been bleached during a first period of irradiation in a culture medium in an aerobic atmosphere until it has regained color and then subjecting this algae to a second period of irradiation wherein hydrogen is produced at an enhanced rate.

29333 Process for producing silicon. Olson, J.M.; Carleton, K.L. US Patent Application 6-387,115. 10 Jun 1982. 27p. Contract AC02-77CH00178.

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A process of producing silicon includes forming an alloy of copper and silicon and positioning the alloy in a dried, molten salt electrolyte to form a solid anode structure therein. An electrically conductive cathode is placed in the electrolyte for plating silicon thereon. The electrolyte is then purified to remove dissolved oxides. Finally, an electrical potential is applied between the anode and cathode in an amount sufficient to form substantially pure silicon on the cathode in the form of substantially dense, coherent deposits.

29334 Optical-diffraction method for determining crystal orientation. Sopori, B.L. US Patent Application 6-376,088. 7 May 1982. 29p. Contract AC02-77CH00178.

Disclosed is an optical diffraction technique for characterizing the three-dimensional orientation of a crystal sample. An arbitrary surface of the crystal sample is texture etched so as to generate a pseudo-periodic diffraction grating on the surface. A laser light beam is then directed onto the etched surface, and the reflected light forms a farfield diffraction pattern in reflection. Parameters of the diffraction pattern, such as the geometry and angular dispersion of the diffracted beam are then related to grating shape of the etched surface which is in turn related to crystal orientation. This technique may be used for examining polycrystalline silicon for use in solar cells.

29335 Process for reducing series resistance of solar-cell metal-contact systems with a soldering-flux etchant. Coyle, R.T.; Barrett, J.M. US Patent Application 6-374,675. 4 May 1982. 23p. Contract AC02-77CH00178.

Disclosed is a process for substantially reducing the series resistance of a solar cell having a thick film metal contact assembly thereon while simultaneously removing oxide coatings from the surface of the assembly prior to applying solder therewith. The process includes applying a flux to the contact assembly and heating the cell for a period of time sufficient to substantially remove the series resistance associated with the assembly by etching the assembly with the flux while simultaneously removing metal oxides from said surface of said assembly.

29336 Separation of biopolymer from fermentation broths. Griffith, W.L.; Compere, A.L.; Westmoreland, C.G.; Johnson, J.S. Jr. (Oak Ridge National Lab., TN). *ACS Symposium Series;* No. 154, 171-192(1981). Contract W-7405-ENG-26.

Application of recent developments in filtration separations have been applied to separation of biopolymers from fermentation broths. More economical production of biopolymers near the site of use would be especially attractive for use in micellar flood programs for enhanced oil recovery. Solutions of the organisms Sclerotium rolfsii producing scleroglucans were used for the tests because the organisms are genetically more stable than the organisms that produce xanthan gums and because their more acid broths are less apt to become contaminated. Three types of filtration, axial filtration, pleated ultrafiltration module, and microscreens were tested on the broth. Filtration results are reported for broths with various preparation histories. An economic comparison is presented for processing of a ton of biopolymer per day, and the microscreening process is shown to be the most efficient, but a polishing step would have to be added. (BLM)

1406 Photovoltaic Power Systems

REFER ALSO TO CITATION(S) 29322

29337 (EPRI-ESC—2881) Resources and economic assessment of centralized and decentralized solar-electric systems. Final report. Katsonis, F.E.; Gourmelon, D. (International Inst. for Applied Systems Analysis, Laxenburg (Austria)). Feb 1983. 139p. NTIS, PC A07/MF A01. Order Number DE83901867.

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The purpose of this report is to compare the WELMM (Water, Energy, Land, Materials, and Manpower) requirements and the production costs of centralized and decentralized electricity-generation systems using solar-photovoltaic devices. The objective is to examine the generic differences between centralized and decentralized electric-power systems by reducing as much as possible the confounding effects of scale economies and technology mixes. The results should aid in the understanding of the physical and economic limits of alternative power system developments. The comparison was undertaken in the framework of a case study of the Languedoc Region in southern France. Four centralized and four decentralized scenarios were compared, and their different system configurations were evaluated. Evaluation of the individual load curves of nine types of consumers was followed by estimation of an aggregate load curve. An electricity-generation model then calculated the required generation capacity and associated storage requirements. The physical resource (WELMM) requirements and production costs of each scenario were calculated using data stored in a technological facilities data system (Facility Data Base). The analysis shows that the centralized systems are cheaper to operate and less resource-intensive than the decentralized scenarios, mainly due to the possibility of using efficient hydrogen-storage systems in the centralized scenarios.

29338 (EUR—8147-DE) Penetration study for a photovoltaic central solar power plant of output 500 kW-1MW with storage-battery capacity. Glatzel, F.; Harden, D.; Korupp, K.H.; Muehle, H. (Rheinisch-Westfaelisches Elektrizitaetswerk A.G., Essen (Germany, F.R.). Abt. Anwendungstechnik; Allgemeine Elektricitaets-Gesellschaft AEG Telefunken, Raumfahrt (Germany, F.R.). Fachbereich Neue Technologien). 1982. 220p. (In German). European Communities Information Service, 2100 M Street NW, Washington, DC 20037.

This study was prepared to contribute to the discussion concerning alternative future energy concepts in Europe. It proves the technical feasibility of an intermediate photovoltaic (pv) power plant and shows the problems associated with that plant. The study is based on a German location (Hamburg) in order to gain different local aspects compared to several studies worked out under parallel contracts. The site, design and operational mode of the pv plant are entirely theoretical, but the study creates a well-founded basis for future pilot project considerations in this power range. Utility participation as the eventual owner and operator of such a system assures maximum cooperation in any problems that relate to interfacing with the utility grid. Their involvement provided valuable information and experience concerning policies and credits for power fed into the utility grid. An extensive computer evaluation of solar data for Hamburg yielded valuable knowledge of the possibilities of solar energy utilization exceeding the frame of this study. A general consideration resulted in guiding rules for the integration of pv power plants into the utility grid. Based on these presumptions a pv power plant was designed regarding to the state-of-the-art, recommending flat plate, tilt angle silicon solar generator modules, lead-acid batteries and static power inverters. Alternative components being under discussion for future application have been considered. A final cost analysis shows clearly, which components need intensive future development with the aim of further price reduction and points out especially the significant issue of area-related costs, which have to be drastically reduced in the future.

29339 **(PB—83-147728) Photovoltaics: technological progress and its future in agriculture. Staff report.** Heid, W.G. Jr. (Economics and Statistics Service, Washington, DC (USA). National Economics Div.). Nov 1982. 129p. NTIS, PC A07/MF A01.

Advances in photovoltaic technology are rapidly bringing it into the range of competitiveness with conventional and other alternative energy source. Photovoltaic systems can be used for nearly all of agriculture's stationary power needs, including energy to operate appliances and to heat farm homes. It is an appropriate technology for small as well as larger sized farms. As researchers and farmers weigh future alternative energy choices, photovoltaic systems should be included in their economic comparisons.

29340 **(SAND—81-7080/8) Intermediate photovoltaic system application experiment operational performance report. Volume 8. For G.N. Wilcox Memorial Hospital, Kauai, Hawaii for December 1982.** (Boeing Computer Services Co., Seattle, WA (USA)). Mar 1983. Contract AC04-76DP00789. 31p. NTIS, PC A03/MF A01. Order Number DE83011031.

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Presented are the data accumulated during December 1982 at the intermediate photovoltaic project at G. N. Wilcox Memorial Hospital, Kauai, Hawaii. Generated energy and environmental (weather) data are presented graphiclaly. Explanations of irregularities not attributable to weather are provided.

29341 **(SAND—81-7085/18) Intermediate photovoltaic system application experiment operational performance report for Lovington Square Shopping Center, Lovington, New Mexico for December 1982.** (Boeing Computer Services Co., Seattle, WA (USA)). Mar 1983. Contract AC04-76DP00789. 32p. NTIS, PC A03/MF A01. Order Number DE83010388.

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Presented are the data accumulated during December 1982 at the intermediate photovoltaic project at Lovington Square Shopping Center, Lovington, New Mexico. Generated energy and environmental (weather) data are presented graphically. Explanations of irregularities not attributable to weather are provided.

29342 **(SAND—81-7086/18) Intermediate photovoltaic system application experiment operational performance report for Newman Power Station, El Paso, Texas for December 1982.** (Boeing Computer Services Co., Seattle, WA (USA)). Mar 1983. Contract AC04-76DP00789. 28p. NTIS, PC A03/MF A01. Order Number DE83010392.

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Presented are the data accumulated during December 1982 at the intermediate photovoltaic project at Newman Power Station, El Paso, Texas. Generated energy and environmental (weather) data are presented graphically. Explanations of irregularities not attributable to weather are provided.

29343 **(SAND—81-7087/8) Intermediate photovoltaic system application experiment operational performance report. Volume 8. For Oklahoma Center for Science and Arts, Oklahoma City, Oklahoma for December 1982.** (Boeing Computer Services Co., Seattle, WA (USA)). Mar 1983. Contract AC04-76DP00789. 28p. NTIS, PC A03/MF A01. Order Number DE83009692.

Presented are the data accumulated during December 1982 at the intermediate photovoltaic project at Oklahoma Center for Science and Arts, Oklahoma City, Oklahoma. Generated energy and environmental (weather) data are presented graphically. Explanations of irregularities not attributable to weather are provided.

29344 **(SAND—81-7089/7) Intermediate photovoltaic system application experiment operational performance report for CDC Light Manufacturing Bldg., San Bernadino, California for September 1982.** (Boeing Computer Services Co., Seattle, WA (USA)). Mar 1983. Contract AC04-76DP00789. 28p. NTIS, PC A03/MF A01. Order Number DE83010391.

Presented are the data accumulated during September at the intermediate photovoltaic project at the CDC Light Manufacturing Bldg., San Bernardino, California. Generated energy and environmental (weather) data are presented graphically. Explanations of irregularities not attributable to weather are provided.

29345 **(SAND—81-7089/8) Intermediate photovoltaic system application experiment operational performance report. Volume 8. For CDC Light Manufacturing Bldg., San Bernadino, California for October 1982.** (Boeing Computer Services Co., Seattle, WA (USA)). Mar 1983. Contract AC04-76DP00789. 27p. NTIS, PC A03/MF A01. Order Number DE83009700.

Presented are the data accumulated during October at the intermediate photovoltaic project at the CDC Light Manufacturing Bldg., San Bernardino, California. Generated energy and environmental (weather) data are presented graphically. Explanations of irregularities not attributable to weather are provided.

29346 **(SAND—81-7089/9) Intermediate photovoltaic system application experiment operational performance report for CDC Light Manufacturing Bldg., San Bernadino, California for November 1982.** (Boeing Computer Services Co., Seattle, WA (USA)). Mar 1983. Contract AC04-76DP00789. 28p. NTIS, PC A03/MF A01. Order Number DE83010389.

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Presented are the data accumulated during November at the intermediate photovoltaic project at the CDC Light Manufacturing Bldg., San Bernadino, California. Generated energy and environmental (weather) data are presented graphically. Explanations of irregularities not attributable to weather are provided.

29347 **(SAND—81-7089/10) Intermediate photovoltaic system application experiment operational performance report. Volume 10. For CDC Light Manufacturing Bldg., San Bernardino, California for December 1982.** (Boeing Computer Services Co., Seattle, WA (USA)). Mar 1983. Contract AC04-76DP00789. 27p. NTIS, PC A03/MF A01. Order Number DE83009699.

Presented are the data accumulated during December at the intermediate photovoltaic project at the CDC Light Manufacturing Bldg., San Bernardino, California. Generated energy and environmental (weather) data are presented graphically. Explanations of irregularities not attributable to weather are provided.

29348 **(SAND—82-7126/1) Reliability-economics analysis models for photovoltaic power systems. Volume 1.** Stember, L.H.; Huss, W.R.; Bridgman, M.S. (Battelle Columbus Labs., OH (USA)). Nov 1982. Contract AC04-76DP00789. 161p. NTIS, PC A08/MF A01. Order Number DE83010295.

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This report describes the development of modeling techniques to characterize the reliability, availability, and maintenance costs of photovoltaic power systems. The developed models can be used by designers of PV systems in making design decisions and trade-offs to minimize life-cycle energy costs.

29349 **(SAND—82-7126/2) Reliability-economics analysis models for photovoltaic power systems. Volume 2.** Stember, L.H.; Huss, W.R.; Bridgman, M.S. (Battelle Columbus Labs., OH (USA)). Nov 1982. Contract AC04-76DP00789. 171p. NTIS, PC A08/MF A01. Order Number DE83010291.

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This report describes the development of modeling techniques to characterize the reliability, availability, and maintenance costs of photovoltaic power systems. The developed models can be used by designers of PV systems in making design decisions and trade-offs to minimize life-cycle energy costs. Three actual intermediate PV system designs were modeled as examples. The input data estimates used and the results of the analyses are presented.

29350 **(SAND—83-0603) Sandia photovoltaic systems definition and application experiment projects.** Jones, G. (Sandia National Labs., Albuquerque, NM (USA)). Apr 1983. Contract AC04-76DP00789. 291p. (CONF-830426—Absts.). NTIS, PC A13/MF A01. Order Number DE83010421.

From ASTM symposium on chevron-notched specimens testing and stress analysis; Louisville, KY, USA (21 Apr 1983).

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A compilation is given of the abstracts and visual material used in presentation at the Fourth Photovoltaic Systems Definition and Applications Projects Integration Meeting held at the Marriott Hotel, April 12-14, 1983, in Albuquerque, New Mexico. The meeting provided a forum for detailed analyses on recently completed and current activities. These activities include systems research, balance-of-system technology development, residential experimentation, and evaluation of intermediate-sized applications.

1407 Solar Thermal Power Systems

REFER ALSO TO CITATION(S) 29324

29351 **(SAND—82-2248) Solar Total Energy Project construction cost history.** Hunke, R.W.; Pappas, G.N. (Sandia National Labs., Albuquerque, NM (USA); USDOE Albuquerque Operations Office, NM). Mar 1983. Contract AC04-76DP00789. 19p. NTIS, PC A02/MF A01. Order Number DE83009784.

A solar energy project using parabolic dish collectors was designed, fabricated, and installed near Shenandoah, GA. A cost history of the construction of the Solar Total Energy Project is presented. Costs are broken down into the various project elements.

29352 **(SAND—83-8005) 10-MWe solar-thermal central-receiver pilot-plant receiver steam generation (Test 1030) evaluation report.** Baker, A.F.; Atwood, D.L. (Sandia National Labs., Livermore, CA (USA)). Mar 1983. Contract AC04-76DP00789. 54p. NTIS, PC A04/MF A01. Order Number DE83010836.

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The Receiver Cold Flow (Test 1010) and Receiver Steam Generation (Test 1030) tests at the 10 MWe Solar Thermal Central Receiver Pilot Plant were preoperational tests to (1) verify receiver operations, (2) develop control functions and field tune controllers, and (3) verify portions of the Plant Operating Procedures. Data from preoperational Test 1030 have been used to make preliminary estimates of receiver performance. Selected days of operation have been evaluated to make estimates of receiver incident power from the heliostat field, panel efficiencies, and receiver efficiencies. In this report, data from the plant's Data Acquisition System are presented for temperature profiles on several panels and are used for efficiency calculations and comparisons of incident power predictions.

29353 **Totally distributed, redundantly structured hardware and software local computer control network.** Damsker, D. (Gibbs & Hill Inc, New York, NY, USA). pp 7p, Paper 82WM 248-3 of IEEE Power Engineering Society winter meeting. New York, NY; IEEE (1982).

From IEEE Power Engineering Society winter meeting; New York, NY, USA (30 Jan 1982).

The presentation of a newly devised local computer control network is based on the conceptual design developled for a solar Cogeneration Industrial Plant. The control system features a modular local computer network, whose redundancy can be designed to meet any availability requirement of a specific application, using the same hardware building blocks. The intrinsic redundancy applied to the component level, with an orderly overlapping, as opposed to a complete system redundancy which is more costly and less reliable. The control software is hierarchical and distributed with a redundant structure and topology. The local computer network uses simple packet switching and routing decision making techniques, based on a contention method, which gives the advantage of conveying messages in the order of their priority. Some details of the concept are presented as they were applied to the solar Cogeneration conceptual design. 7 refs.

1408 Ocean Thermal Gradient And Salinity Gradient Power Systems

29354 **(AD-A—123494/7) Ocean engineering for ocean thermal energy conversion.** (National Research Council, Washington, DC (USA). Marine Board). 1982. 79p. NTIS, PC A05/MF A01.

The panel on OTEC Ocean Engineering of the National Research Council was formed to assess the state of ocean engineering knowledge, technology, and practice necessary to design, construct, and operate OTEC plants. The panel concentrated its study on platforms, moorings, and foundations; the cold water pipe; and submarine cables for electric power transmission. The panel did not address the design and engineering of power plants; institutional and management issues or the commercial feasibility of OTEC; or its environmental impacts. The panel focused instead on determining the state of development of several of the ocean engineering technologies needed to design and construct a 40-MWe OTEC plant; it also examined the technical feasibility and advantages of larger and smaller plants.

29355 **(CONF-810622—Vol.1) Proceedings of the 8th ocean energy conference.** (Marine Technology Society, Washington, DC (USA)). Jun 1981. Contract W-31-109-ENG-38. 565p. (DOE/CONF—810622-Exc.Vol.1). NTIS, PC A24. Order Number DE83002533.

From 8. ocean energy conference; Washington, DC, USA (7 Jun 1981).

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Separate abstracts were prepared for 60 papers in this volume of conference proceedings. None other papers in the proceedings were previously abstracted for EDB. Also included in the proceedings but not indexed separately are six workshop summaries and a session introduction. (LEW)

29356 (CONF-810622—Vol.1, pp 19-23) **OTEC cold water pipe technology development plan.** McGuinness, T. (National Oceanic and Atmospheric Administration, Rockville, MD). Jun 1981. NTIS, PC A24.

From 8. ocean energy conference; Washington, DC, USA (7 Jun 1981).

The OTEC Cold Water Pipe (CWP) Technology Development Plan (TDP) has evolved over the past four years into three elements: design and analysis, laboratory testing and at-sea testing. All work efforts are continuously cross correlated to maximize the value of each element in the TDP. Recently completed and planned future work efforts in the CWP TDP will be presented. Emphasis will be placed on the recently awarded CWP 1/3 scale at sea test.

29357 (CONF-810622—Vol.1, pp 25-30) **Comparative study of three OTEC cold water pipe design analysis computer models.** Jawish, W.K. III (Giannotti & Associates, Inc., Annapolis, MD); Scotti, R. Jun 1981. NTIS, PC A24.

From 8. ocean energy conference; Washington, DC, USA (7 Jun 1981).

The National Oceanic and Atmospheric Administration (NOAA) has sponsored the development of three computer-based analytical models of the Ocean Thermal Energy Conversion (OTEC) Cold Water Pipe (CWP) Subsystem. Two of these models, the NOAA/DOE and the NOAA/ROTECF codes are based on linear theory in the frequency domain and treat the CWP as an elastic beam. The third code, NOAA/TRW, is based on a nonlinear formulation in the time domain which treats the CWP as either a beam or quasi-static thin shell. The purpose of this study is to test the capabilities and limitations of each of these models and to compare their predictions and computer costs to each other.

29358 (CONF-810622—Vol.1, pp 31-33) **OTEC cold water pipe laboratory test program.** Hove, D. (Science Applications, Inc., El Segundo, CA); Osofsky, I.; Grote, P.; Peterson, D.; Lee, T. Jun 1981. NTIS, PC A24.

From 8. ocean energy conference; Washington, DC, USA (7 Jun 1981).

Parallel composite materials and model basin test programs were performed to resolve engineering issues surfaced in previous OTEC Cold Water Pipe Systems Design Studies. Three test projects were undertaken to investigate fiberglass reinforced plastic (FRP) sandwich materials performance in seawater, FRP cold water pipe deployment and OTEC ocean system operation. Although some development and/or demonstration remains, the present program provided increased confidence that FRP sandwich wall CWP structures can be built, deployed and operated under established OTEC design requirements.

29359 (CONF-810622—Vol.1, pp 35-44) **Response of the OTEC cold water pipe to current-induced hydrodynamic loading.** Griffin, O.M. (Naval Research Lab., Washington, DC). Jun 1981. NTIS, PC A24.

From 8. ocean energy conference; Washington, DC, USA (7 Jun 1981).

This paper is limited in scope to consideration of the problems caused by vortex shedding from flexible, bluff cylinders in steady current flows. In particular, the steady deflections caused by the amplified drag forces that accompany vortex-excited oscillations are considered. Emphasis is placed upon the discussion of design methods, applications of these methods in practice, and comparison with available experimental data. A discussion is given of laboratory and field studies that have been conducted with model OTEC cold water pipes. Various means that have been developed for the suppression of vortex-excited oscillations also are discussed. A comparison is made of the effectiveness of various suppression devices and procedures, and practical approaches to implementing their application are presented. The implications of vortex-induced hydrodynamic drag and vortex suppression in OTEC cold water pipe design are discussed briefly. Some typical examples are given to illustrate how these results can be employed in OTEC cold water pipe design.

29360 (CONF-810622—Vol.1, pp 45-49) **Conceptual design of a shelf-mounted OTEC platform/CWP system.** Green, W.L. (McDermott, Inc., New Orleans, LA); Calkins, D.E.; Harrison, G.E.; Witter, R.W. Jun 1981. NTIS, PC A24.

From 8. ocean energy conference; Washington, DC, USA (7 Jun 1981).

The conceptual design and installation aspects of CWP systems for shelf-mounted OTEC power plants in Puerto Rico and Hawaii are considered. A marine railway approach was chosen for installation of the CWP. Methods are presented for pulling the track for the railway down the pipe fairway to final location. Both the marine railway and the shelf-mounted platform that houses the OTEC power plant must have an anodic or equivalent corrosion protection system, which would require the same inspection and maintenance procedures as currently used for offshore oil production platforms. Further, the shelf-mounted OTEC platform interface with the electric power transmission cable and discharge pipe is examined. Fabrication/mobilization cost and schedule estimates are given for the preferred single CWP when using the marine railway installation method at the Puerto Rico and Hawaii OTEC sites. Recommendations are stated in connection with optimization of platform/OTEC power plant configurations and intake/discharge fluid flow phenomena for site-specific preliminary design.

29361 (CONF-810622—Vol.1, pp 51-59) **Inspection, maintenance and repair considerations in the design of OTEC ocean engineering system.** Fjeld, S. (Det norske Veritas, Oslo, Norway). Jun 1981. NTIS, PC A24.

From 8. ocean energy conference; Washington, DC, USA (7 Jun 1981).

Due to the specific configuration, water depths and purpose of the OTEC the adequacy as well as the relevance of current design criteria for ships as well as for onshore and offshore structures should be reevaluated prior of their introduction for OTEC projects. The main difference is associated with large water depths, structural elements of unusual dimensions, pronounced cyclic loadings promoting fatigue effects and exposure to sea water of elevated temperatures, promoting corrosion and materials deterioration. Current deisgn criteria are meant to specify a minimum standard to obtain a structure of an acceptable probability of failure when completed. They normally assume the structures to be necessary to maintain this low probability during the life time of the structure. However, because inspection, maintenance and repair are all very restricted for the OTEC the latter assumption is not realistic. Special criteria are necessary to maintain an adequate structural reliability and - even more so - to optimize the total economy of structural design, construction, operation (downtime), inspection, maintenance and repair. The paper is a summary of a study undertaken to given recommendations for modifications of current requirements to obtain an optimal solution considering all the mentioned expenses throughout the lifetime of the structure. Measures to reduce the failure and deterioration susceptibility in terms of improved material qualities, protection against corrosion and abrasion, reduced stress levels, improved construction control etc. are evaluated and related to the corresponding reduction in inspection, maintenance and repair.

29362 (CONF-810622—Vol.1, pp 61-68) **Study on dynamical behavior of 1MW OTEC CWP in Japan.** Iso, S. (Tokyo Kyuei Co., Ltd., Japan); Yamashita, Y.; Shimogo, T.; Yoshida, K. Jun 1981. NTIS, PC A24.

From 8. ocean energy conference; Washington, DC, USA (7 Jun 1981).

Basic design data are provided for ongoing 1 MW OTEC research that is chaired by Electrotechnical Laboratory (ETL), Ministry of International Trade and Industry (MITI) in Japan. The work is focused on the analyses of dynamical behavior of steel-made CWP that is excited by wave, current, and single-moored-buoy. In designing OTEC CWP, it is quite important to understand the dynamical responses, however, their characteristics have not been presented clearly in the past. In this study, the CWP is 800 m in length, 1.8 m in the inside diameter and is connected with the buoy by ball-joint. The analytical model is formulated under the assumptions that the system can be expressed by linearized form as the vibration of the CWP is relatively small. Power spectral density and root-mean-square (rms) values as well as frequency response of the CWP are presented. Based on the analytical study, the following conclusion is derived: the qualitative and quantitative evaluations of the CWP show that the CWP under consideration is structurally sound.

29363 (CONF-810622—Vol.1, pp 69-75) **Comparison of four computer programs for cold water pipe analysis.** Daoud, N.; Gershunov, E.M.; Ozudogru, Y.; Alinaghian, Y. Jun 1981. NTIS, PC A24.

From 8. ocean energy conference; Washington, DC, USA (7 Jun 1981).

The main objective of this work is to investigate the capabilities and limitations of the four methods of cold water pipe analysis: ROTEC, NOAA/DOE, HULPIPE and GMDI. A sensitivity analysis of each method was conducted separately to establish its nominal input parameters. Subsequently, computer results from the four methods were compared in both head and beam seas. A comparison of the predicted response of OTEC-1 cold water pipe is also discussed in some detail.

29364 (CONF-810622—Vol.1, pp 77-83) **Model basin tests of a baseline 40 MW OTEC pilot plant.** George, J.; Richards, D. (Johns Hopkins Univ., Laurel, MD). Jun 1981. NTIS, PC A24.

From 8. ocean energy conference; Washington, DC, USA (7 Jun 1981).

A 1/30th-scale model of a floating 40-MW OTEC pilot plant has been subjected to wave conditions that the prototype would experience as a moored plant at Puerto Rico or Hawaii, or as a cruising plantship in the South Atlantic Ocean east of Brazil. The model survived the design wave conditions for the three sites, with more than adequate stability margins. Another concern for the Puerto Rico and Hawaii sites is the possibility that large green water waves breaking over the bulwark level would damage the OTEC power system components or other critical equipment located top-

side. The tests included modifications to the hull form that would reduce this problem. Additional data were obtained on seawater system parameters, cold water pipe motions, and mooring forces.

29365 (CONF-810622—Vol.1, pp 85-93) **OTEC mooring system development: recent accomplishments.** Ross, J.M. (National Oceanic and Atmospheric Administration, Rockville, MD); Wood, W.A. Jun 1981. NTIS, PC A24.

From 8. ocean energy conference; Washington, DC, USA (7 Jun 1981).

The mooring system for a floating OTEC platform consists of a seafloor foundation, a platform foundation, and a connecting line. This paper introduces the OTEC mooring system with a brief historical overview, reviews developmental work accomplished during the past year, and then presents a new look at life cycle costs for an example mooring system. Since June 1980 a significant effort has included work leading to a better understanding of anchoring capabilities and problems; refinement of an existing mooring analytical model; a review of OTEC past mooring designs; and the production of a mooring system technology development plan. A major development in the past year was a new upward estimate of mooring system lifetime costs resulting from downward-revised estimates of wire rope service life.

29366 (CONF-810622—Vol.1, pp 95-106) **OTEC moorings and anchoring systems: technology development plan.** Bailey, S.; Vega, L. (Giannotti & Associates, Inc., Berkeley, CA). Jun 1981. NTIS, PC A24.

From 8. ocean energy conference; Washington, DC, USA (7 Jun 1981).

The permanent offshore mooring of large OTEC systems in 4000 to 6000 foot water depths is an engineering endeavor worthy of an exacting, methodical development program. The OTEC Mooring System Technology Development Plan was compiled to accomplish this task. This paper presents an outline of the five-year program envisioned for implementation by the government through NOAA's Office of Ocean Technology and Engineering Services. State-of-the-art industrial technology will be utilized where possible to facilitate early deployment of the working OTEC system. However, the conditions imposed by OTEC requirements will necessitate expansion of new technology. Results of projected ongoing research programs will be beneficial to the entire industry with final deployment of OTEC adding a new deepwater dimension to offshore technology.

29367 (CONF-810622—Vol.1, pp 107-115) **Suppression of mooring cable strumming.** Meggitt, D. (CEL, Port Hueneme, CA); Kline, J.; Pattison, J. Jun 1981. NTIS, PC A24.

From 8. ocean energy conference; Washington, DC, USA (7 Jun 1981).

Mooring cables exposed to ocean currents are often subject to vortex-induced vibrations, known as strumming. These vibrations can cause several undesirable effects on the mooring system. High cyclic rates of stress reversals result in cold working of the cable and its terminations, promoting fatigue and inducing potential premature component failure. Also, strumming causes an increase in cable drag that degrades the hydrodynamic performance of the moored system. The strumming of mooring cables can be significantly reduced by the attachment of devices that modify the fluid/cable boundary layer in such a way that the overall magnitude of the vortex shedding driving force is reduced. These devices are commonly termed Strumming Suppression Devices (SSDs). Strumming suppression solutions have always been specific to the problem at hand because the precise operating mechanisms of the various SSDs have not been well understood. A series of controlled experiments were performed to provide a baseline for the understanding of these mechanisms and to further characterize the performance of several SSDs in a quantitative manner.

29368 (CONF-810622—Vol.1, pp 117-125) **Practicalities of concrete for OTEC applications.** Browne, R.D.; Bury, M.R.C. Jun 1981. NTIS, PC A24.

From 8. ocean energy conference; Washington, DC, USA (7 Jun 1981).

The potential to use concrete in both the support structure and cold water pipe of OTEC systems has often been considered. In their design development of North Sea concrete platforms and other marine structures, Taylor Woodrow have conducted extensive investigations into factors influencing the durability of concrete in the marine environment, and related these to the specification, inspection and repair of maritime structures. The application of this technology to the practicalities of OTEC systems in concrete was studied. This paper presents highlights from the completed study, drawing conclusions on concrete as a material for marine construction, the practicalities of constructing, monitoring and maintaining large marine structures, and also giving outline proposals for a flexible hinge to joint rigid CWP sections.

29369 (CONF-810622—Vol.1, pp 127-131) **Corrosion control of an OTEC platform.** Carlos, W.C. (Harco Corp., Medina, OH). Jun 1981. NTIS, PC A24.

From 8. ocean energy conference; Washington, DC, USA (7 Jun 1981).

A OTEC platform, no matter what material it is made of, must survive a 30 year life in a very hostile environment, seawater. The prevention of corrosion on the platform and subsystem will determine the viability of the project. Examples where lack of corrosion prevention proved disastrous will be reviewed. Corrosion rates, design data requirements, corrosion provention methods, cathodic protection, coating systems, marine fouling, inspection and maintenance interface problems will all be reviewed and recommendations made.

29370 (CONF-810622—Vol.1, pp 133-143) **Design and integration of a 40 MWe OTEC shelf-mounted pilot plant.** Moak, K.E.; Hagerman, G.M.; Wu, J.T.C. (Gibbs & Cox, Inc., Arlington, VA). Jun 1981. NTIS, PC A24.

From 8. ocean energy conference; Washington, DC, USA (7 Jun 1981).

The Gibbs & Cox, Inc. Shelf-Mounted OTEC Platform has been developed for the US Department of Energy as a Reference Baseline Design for the OTEC Pilot Plant demonstration program. This paper describes the design of the fixed platform and cold water pipe and integration of the Lockheed Missiles and Space Company's PSD II power system with other OTEC subsystems. The platform consists of a superstructure and submerged power module supported by a steel jacket base that is pinned to the bottom by a pile foundation. The platform is sited seaward of the shelf-break off Punta Yeguas, Puerto Rico, in just over 300 feet of water. The 5700-foot-long cold water pipe (CWP) is of FRP/syntactic foam construction and is pinned to the 30° slope by a series of pile-anchored steel jacket foundations. The ducting between the power module and the CWP is incorporated within the platform base structure. The platform base, power module, and superstructure can be constructed at any major US shipyard facility, while the CWP will require special facilities constructed near the platform site. The Shelf-Mounted Reference Baseline has a design power output of 40 MWe at a ΔT of 40.2°F. The cost through acquisition and deployment is $370 M ($9250/KW) with the total cost over the expected 30-year life being $762 M in FY 81 dollars.

29371 (CONF-810622—Vol.1, pp 145-153) **New and viable OTEC application.** Coffay, B.; Rabas, T.J. (Westinghouse Electric Corp., Lester, PA). Jun 1981. NTIS, PC A24.

From 8. ocean energy conference; Washington, DC, USA (7 Jun 1981).

A recent study of the commercialization potential of making fresh water, using OTEC technology yielded a technically feasible and economically attractive concept. The new concept developed is a floating water factory which produces electricity in sufficient quantity to power only the water production operation. A closed cycle OTEC system is used to generate the power to operate pumps required by a multistage flash (MSF) evaporator. An economic analysis of the OTEC/MSF system shows that the system has great potential for being deployed in the US Virgin Islands (near St. Croix) at a cost which allows for fresh water product costs competitive with fossil fired multistage flash plants currently used on that island.

29372 (CONF-810622—Vol.1, pp 155-159) **Small-scale OTEC applications.** Janson, J.E.; Hoegbom, T. (SWECO, Stockholm, Sweden). Jun 1981. NTIS, PC A24.

From 8. ocean energy conference; Washington, DC, USA (7 Jun 1981).

Small-scale OTEC plants are not only to be regarded as small models of large-scale OTEC plants. They have their own market. A 1 MW OTEC plant could be an attractive alternative to a diesel plant, provided the natural conditions favor an OTEC installation. The very first OTEC plants to be commercial would seem to be of a shore-based type with the cold water pipe installed on a steep sea bottom slope. For such a plant in a size range of 1 MW, the necessary amount of money and development work is less than for large-scale OTEC plants. Shore-based OTEC plants can also preferably be integrated with plants which utilize the cold water for fresh water production by means of a low temperature distillation process.

29373 (CONF-810622—Vol.1, pp 161-166) **Feasibility study of the OTEC complex for island applications.** Kamogawa, H. (Toshiba Corp., Kawasaki, Japan); Nakamoto, Y. Jun 1981. NTIS, PC A24.

From 8. ocean energy conference; Washington, DC, USA (7 Jun 1981).

OTEC will be important for the island countries which have no energy resources. This paper discussed the OTEC-Mariculture Complex, a combined system the OTEC, Mariculture, desalination and other units. The island economy will be improved using the combined system much more than by using OTEC system only.

29374 (CONF-810622—Vol.1, pp 167-173) **Preliminary design of 1 MWe OTEC test plant.** (Electrotechnical Lab., Ibaraki, Japan). Jun 1981. NTIS, PC A24.

From 8. ocean energy conference; Washington, DC, USA (7 Jun 1981).

Based upon the technological potential related to OTEC in Japan, achieved since 1974, an ocean based 1 MWe test plant experiment was planned in the revised Sunshine Project. The preliminary design of this plant is described. The plant is composed of a barge type platform and a mooring buoy which holds the CWP. They are connected by a detachable A-shaped frame. The power system is a closed cycle NH_3 loop, equipped with shell/tube and shell/plate type HX's, combined with cleaning systems. The CWP is a steel pipe, upper half of its surface being covered with polyethylene layers. Specifications of the system and the key components as well as the construction and deployment processes are described. Also experiment items are presented.

29375 (CONF-810622—Vol.1, pp 175-181) **Second generation design of commercial OTEC plants.** Rogalski, W.W. Jr.; Deuchler, W.P.; Hudon, T.J. (Gibbs & Cox, Inc., Arlington, VA). Jun 1981. NTIS, PC A24.

From 8. ocean energy conference; Washington, DC, USA (7 Jun 1981).

Commercial size ocean thermal energy conversion (OTEC) power plants provide a unique opportunity to utilize a solar resource previously untapped for the production of baseload electrical power or energy intensive products. The study aimed at producing a second generation OTEC design is described. Four primary areas of design are discussed including platform arrangements, mooring system, cold water pipe and power system. Impacts on overall platform design are analyzed through trade-off studies. The preliminary results and trends indicated by these studies are presented along with candidate platform illustrations.

29376 (CONF-810622—Vol.1, pp 217-227) **Geothermal-enhanced OTEC (GEOTEC) resources and plant concepts.** Dugger, G.L.; Paddison, F.C.; Perini, L.L. (Johns Hopkins Univ., Laurel, MD). Jun 1981. NTIS, PC A24.

From 8. ocean energy conference; Washington, DC, USA (7 Jun 1981).

For many ocean-shore sites that have neither ocean surface temperatures warm enough for conventional ocean thermal energy conversion (OTEC) plants, nor a geothermal resource hot enough for a flash-electric geothermal plant, the wedding of a moderate-temperature (100 to 200°C) geofluid source with OTEC cycle technology could be attractive. Such hybrid GEOTEC plants will be most efficient at sites far from the equator where low surface seawater temperatures (0 to 8°C) are available year-round. Worldwide geothermal resources and the conditions most relevant for GEOTEC are outlined. Performance estimates for plants using a single closed cycle and dual closed cycles (two working fluid loops) indicate thermal efficiencies up to 4 to 6 times those for OTEC plants. The problem of large, long OTEC cold-water intake and return pipes is replaced by the need for geofluid production and reinjection wells.

29377 (CONF-810622—Vol.1, pp 229-233) **Integrated OTEC-mariculture system.** Werner, E. (Puerto Rico Office of Energy, Santurce). Jun 1981. NTIS, PC A24.

From 8. ocean energy conference; Washington, DC, USA (7 Jun 1981).

Ocean Thermal Energy Conversion (OTEC) is a technology which is being actively developed, and can benefit from the legislation created to encourage rapid commercialization. The OTEC thermal resource is site specific and restricted to a relatively narrow zone. Energy requirements in these areas are relatively light, and can easily be achieved by the OTEC configurations now in the planning stages. For those Third World countries which have extensive oceanic coasts, development of marine resources, particularly fisheries, is a much more crucial venture than increased production of energy. Equally important, perhaps, from the point of view of making OTEC a viable commercial operation is the economic value which an OTEC associated mariculture system would have. The purpose of this paper is to review the effluent characteristics and plume dynamics of a model 40 MW nearshore OTEC plantship, and present a conceptual design for a mariculture system which can be integrated with the OTEC plant.

29378 (CONF-810622—Vol.1, pp 235-247) **Assessment of OTEC-based mariculture operations.** Bailey, S.; Vega, L. (Giannotti & Associates, Inc., Berkeley, CA). Jun 1981. NTIS, PC A24.

From 8. ocean energy conference; Washington, DC, USA (7 Jun 1981).

The impact of OTEC induced upwelling on the environment is assessed and beneficial uses for the upwelled waters are considered. The technical feasibility of OTEC-based mariculture operations is evaluated. Their ideal production potential is established based on published data from field experiments and commercial aquaculture operations. Mariculture of primary producers, shellfish, and finfish is considered. Hardware, space, and manpower requirements and operational economics are discussed for each mariculture operation.

29379 (CONF-810622—Vol.1, pp 253-257) **Feasibility study on thermoelectric OTEC at ETL.** Kajikawa, T. (MITI, Ibaraki, Japan); Ohta, T.; Hirabayashi, M.; Miyata, H.; Uemura, K. Jun 1981. NTIS, PC A24.

From 8. ocean energy conference; Washington, DC, USA (7 Jun 1981).

The thermoelectric OTEC is now undergoing the preliminary evaluation by the small scale thermoelectric OTEC module experiments in parallel with system analysis. At the first stage, the objectives are (1) to realize the technical limit of the thermoelectric generation under the OTEC temperature range based on the state-of-the-art technology, (2) to experimentally clarify the temperature allocation in the heat flow direction at 20°C in overall temperature difference, and (3) to estimate the characteristics of a large scale thermoelectric OTEC module in consideration of the performance distribution based on the 30W class small scale module experiment. The preliminary experiment was successful to generate 26.7W in the case of 27°C in overall temperature difference. The detail measurements have been achieved to detect the power characteristics and the temperature allocation in the heat flow direction. It is concluded that as the parasitic temperature difference loss was very large, the substantial improvement of the adhesion between the electrode and the heat transfer wall should be needed. Moreover, the manufacturing process should be essentially improved in order to make up a large scale module economically.

29380 (CONF-810622—Vol.1, pp 259-267) **Design of 100 KW thermo-electric OTEC experimental power plant.** Kato, H. (Tokyo Univ., Japan); Yamane, K. Jun 1981. NTIS, PC A24.

From 8. ocean energy conference; Washington, DC, USA (7 Jun 1981).

A design work of 100 Kw thermo-electric OTEC power generator and its test facility is carried out. The generator is designed based on commercially available technologies and materials in Japan. The result may not suggest immediate commercialization of the plant, however it clearly showed technical feasibility of the plant and direction of the element material development. The test facility is designed to install at isolated small island, so that its platform is built at dockyard and towed to the site. Chain moored, block fixed and buried in trench cold water pipe are designed to fit respective installing depth.

29381 (CONF-810622—Vol.1, pp 271-275) **Overview and recent progress on open-cycle OTEC power systems.** Penney, T.R.; Shelpuk, B. (Solar Energy Research Inst., Golden, CO). Jun 1981. NTIS, PC A24.

From 8. ocean energy conference; Washington, DC, USA (7 Jun 1981).

A significant ongoing advanced R & D program is endeavoring to develop alternate power cycles that will make the power from the sea more cost-effective. This program is structured along the lines of alternative cycles to convert the thermal resource and alternate ocean energy resources such as waves, currents, or salinity gradients. The alternative thermal-cycle work is described, specifically progress related to the Claude or open cycle. Also summarized is development of the turbine and direct heat exchangers and also critical aspects of deaeration of seawater on open-cycle systems.

29382 (CONF-810622—Vol.1, pp 277-289) **Design and development of an open cycle OTEC turbine with particular emphasis on mechanical design aspects of rotor blades.** Coleman, W.H. (Westinghouse Electric Corp., Lester, PA); Rogers, J.D.; Thompson, D.F.; Young, M.I. Jun 1981. NTIS, PC A24.

From 8. ocean energy conference; Washington, DC, USA (7 Jun 1981).

Optimization studies of the Open Cycle OTEC system have shown that an integrated plant size of around 100 MWe output should provide minimum cost per kW in a production configuration. The Open Cycle OTEC operates a steam turbine with very low density vapor evaporated from warm surface water at a pressure of less than one-half psi. Cold water drawn from deep in the ocean condenses the vapor after exit from the turbine. The chosen baseline has a shaft power of 140 MWe and an inlet flow of nearly 3,000,000 cfs. This extremely large volume flow resulted in selection of a single stage vertical turbine with 40 foot long blades and a tip diameter of 144 feet, operating at 200 rpm. Thermodynamic and mechanical design of a turbine are highly integrated. Since it is not possible to simply scale-up an existing turbine design, Westinghouse is preparing a turbine design and defining the requirements for further development and manufacturing of the baseline Open Cycle OTEC turbine.

29383 (CONF-810622—Vol.1, pp 291-296) **Experimental demonstration of the feasibility of the mist flow ocean thermal energy process.** Ridgway, S.L.; Lee, C.K.B.; Hammond, R.P. (R & D Associates, Marina del Rey, CA). Jun 1981. NTIS, PC A24.

From 8. ocean energy conference; Washington, DC, USA (7 Jun 1981).

The Mist Flow Ocean Thermal Energy Process is a practical method for exploiting the ocean temperature difference without using heat exchangers or large vapor turbines. Warm ocean surface water is sprayed upward into the bottom of an evacuated vertical duct. Vapor flashes from the sprayed water droplets and drags them upward as it proceeds to the top of the duct. There the vapor is condensed by cold water obtained from the depths. The validity of the concept has been demonstrated in a set of experiments conducted in a 4-meter tall transparent test column of 23 x 36 cm cross section. The coupling between the vapor and the droplets remained strong as energy equivalent to over 60 meters of lift was transferred from the vapor to the water droplets. Power plant designs based on these experimental data imply costs between $1500 and $2000 per kilowatt for power plant sizes in the 10 MW range. Power plants operating with only 16°C temperature difference appear practical.

29384 (CONF-810622—Vol.1, pp 297-302) **Periodic accelerations in a rising foam column.** Zener, C.; Noriega, J. (Carnegie-Mellon Univ., Pittsburgh, PA). Jun 1981. NTIS, PC A24.

From 8. ocean energy conference; Washington, DC, USA (7 Jun 1981).

More than 100 years ago Rayleigh showed that oscillations spontaneously arise in an air filled glass tube one end of which is hot and closed, the other is cold and open. The same thermo-mechanical coupling between medium and wall leads to periodic flow accelerations in foam rising in a 4″ diameter, 30′ high glass column. The foam in the upper part of the column, where this acceleration takes place, has an amazingly high thermal diffusivity coefficient, more than 10,000 times greater than air. The origin of the periodic accelerations to this high thermal diffusivity is traced. This high thermal diffusivity has in the past blocked progress in developing a viable foam lift system for Ocean Thermal Energy Conversion (OTEC).

29385 (CONF-810622—Vol.1, pp 319-327) **Heat exchanger tests at Argonne National Laboratory.** Panchal, C.; Hillis, D.; Seren, L.; Yung, D.; Lorenz, J.; Thomas, A.; Sather, N. (Argonne National Lab., IL). Jun 1981. NTIS, PC A24.

From 8. ocean energy conference; Washington, DC, USA (7 Jun 1981).

Results of heat exchanger testing are presented, with data reported previously given for comparison. Two small (< 0.1 MWt) exchangers were tested: a Rocketdyne concentric tube evaporator and a Tranter plate-gasket unit which was tested before and after the application of the Linde High-Flux surface to the ammonia side. A Manning-Lewis plain tube condenser was tested to verify the validity of existing correlations for 40°F water. Results are given for a Rosenblad plate-shell exchanger made with AL-6X alloy steel and a Trane brazed aluminum unit with extruded water-side passages. Results are also given for the Alfa-Laval Mini-OTEC evaporator, which was tested after reconditioning and some modifications by the manufacturer. Results are also given for tests which were conducted to determine the accuracy and short-term stability of three types of temperature sensors used in the OTEC program.

29386 (CONF-810622—Vol.1, pp 329-334) **Transient behavior and control of closed-cycle OTEC power systems.** Zadeh, M.M.; Lavi, A. (ERDI, Inc., Pittsburgh, PA). Jun 1981. NTIS, PC A24.

From 8. ocean energy conference; Washington, DC, USA (7 Jun 1981).

A simple mathematical model is presented to study the transient behavior of an OTEC plant equipped with a bypass valve. Transient simulations of different heat exchanger concepts are presented: horizontal falling film; vertical falling film; pool boiling; and two phase flow. The dynamic response of these exchanger concepts is compared by incorporating each exchanger system in the same OTEC power cycle dynamic model. The results of the study show that an OTEC power cycle is dynamically stable over a broad range of operating conditions. Heat exchanger dynamics dominate cycle dynamics. We have concluded that bypass valve control is suitable for all OTEC heat exchangers analyzed. The bypass-valve control results in a reduction of cycle efficiency without derating the power system designed on the basis of steady-state performance criteria.

29387 (CONF-810622—Vol.1, pp 335-345) **Materials considerations for the aluminum-tubed OTEC test article heat exchangers.** Kratz, J.L. Jun 1981. NTIS, PC A24.

From 8. ocean energy conference; Washington, DC, USA (7 Jun 1981).

This paper presents the aterials selection and welding information developed for the aluminum tubed OTEC heat exchangers. Special attention is given to the selection of the aluminum 3003 alclad tubes, the aluminum 1100 roll-bond clad tubesheets, and the tube-to-tubesheet welding. Protective coatings, cathodic protection, and anticipated special corrosion considerations are also presented. In a laboratory simulated tube-to-tubesheet-area erosion test actual OTEC aluminum tubing exhibited substantial tube alclad loss after 30 days exposure at 10 feet per second.

29388 (CONF-810622—Vol.1, pp 361-369) **Ammonia water systems in OTEC power plants.** Sheets, H.E.; Avery, K.A. (Analysis & Technology, Inc., Stonington, CT). Jun 1981. NTIS, PC A24.

From 8. ocean energy conference; Washington, DC, USA (7 Jun 1981).

The use of a two-fluid mixture in the thermodynamic cycle has been studied for an OTEC power system using ammonia-water as the binary mixture. The investigated cycles use an absorber similar to those used in absorption refrigeration systems, rather than a condenser. A single-stage cycle using a single absorber and evaporator has been optimized for an assumed range of temperatures, pressures, and mixture ratios in the cycle. An additional study was conducted on a cycle with two-fluid loops serving two absorbers and two evaporators. The data indicate a cycle efficiency maximum approaching the Rankine cycle efficiency for a single-stage system. The two-stage system proved viable, but has not yet been optimized. On the basis of the data analyzed to date, there is a possibility of developing a more advanced ammonia-water system with increased total efficiency.

29389 (CONF-810622—Vol.1, pp 371-377) **Overview of the OTEC biofouling, corrosion, and materials program.** Draley, J.E.; Darby, J.B. Jr. (Argonne National Lab., IL). Jun 1981. NTIS, PC A24.

From 8. ocean energy conference; Washington, DC, USA (7 Jun 1981).

The Biofouling, Corrosion, and Materials (BCM) base-technology Program was established early in 1978 with detailed technical management provided by Argonne National Laboratory. It was a successor to the earlier OTEC Biofouling and Corrosion Program, managed by the Battelle Pacific Northwest Laboratory. Although an overview of all OTEC corrosion problems was maintained, the responsibility for solving corrosion and materials problems was largely restricted to the Power Systems, with the greatest effort related to heat exchangers. Programmatic decisions were made on the basis of discussions with OTEC contractors and DOE program managers and through meetings of the OTEC BCM Advisory Panel. Priorities were established in terms of immediate overall OTEC program requirements, as outlined in the Ocean Systems Branch Multi-Year Plan (Draft) dated October, 1979. The greatest programmatic effort has been applied to understanding the problem of fouling of heat-transfer surfaces and to examining possible solutions to this problem. This experimental work was largely carried out by subcontractors; development of the necessary field-operable sensitive heat-transfer monitors was completed at Argonne National Laboratory. Corrosion tests were also run by subcontractors. Necessary work in the BCM area is expected to continue, as feasible, at the Seacoast Test Facility.

29390 (CONF-810622—Vol.1, pp 379-387) **Biofouling countermeasure evaluations for OTEC heat exchangers.** Lewis, R.O. (LaQue Center for Corrosion Technology, Inc., Wrightsville Beach, NC). Jun 1981. NTIS, PC A24.

From 8. ocean energy conference; Washington, DC, USA (7 Jun 1981).

Several promising countermeasure methods for maintaining heat transfer efficiency in OTEC heat exchangers have been evaluated. Heat transfer monitors are being utilized to evaluate the effectiveness of several countermeasure methods of candidate OTEC heat exchanger tubing. Countermeasure methods being evaluated include ones employing abrasize slurries, Amertap sponge rubber balls (alone and in combination with continuous and intermittent chlorination), M.A.N. brush, and continuous and intermittent chlorination.

29391 (CONF-810622—Vol.1, pp 389-397) **Special tube monitors (STMs) for OTEC.** Kuzay, T.M.; Panchal, C.B.; Gavin, A.P.; Grannemann, G.N. (Argonne National Lab., IL). Jun 1981. NTIS, PC A24.

From 8. ocean energy conference; Washington, DC, USA (7 Jun 1981).

A Heat Transfer Monitor (HTM) is a sensitive device which quantifies development of biofouling in the OTEC heat exchanger surfaces in terms of degrading heat transfer coefficient as biofouling progresses. The Carnegie-Mellon University (CMU) type HTM has been successfully utilized to date for plain circular OTEC heat exchanger tubes. With the development of compact heat exchangers for OTEC with non-circular and/or complex tube geometries, a device independent HTM (Universal Monitor) concept is being sought. For the meantime, however, Argonne National Laboratory (ANL) has resorted to methods of using the CMU type HTM for a rectangular OTEC heat exchanger tube as well as for enhanced circular tubes. Such HTMs are named Special Tube Monitors (STMs). The theory, formulation, analytical solutions and laboratory test results are presented for the novel use of the CMU HTM concept with such enhanced OTEC tubes.

29392 (CONF-810622—Vol.1, pp 399-402) **Development of cleaning system at the Seacoast Test Facility.** Genens, L.; Stevens, H. (Argonne National Lab., IL). Jun 1981. NTIS, PC A24.

From 8. ocean energy conference; Washington, DC, USA (7 Jun 1981).

A program has been initiated at Argonne National Laboratory with the purpose of furthering the development of cleaning systems to be used in OTEC heat exchangers. Although the scope of the effort includes chlorination and chemical systems, the major emphasis will be on mechanical cleaning methods. The program is directed toward cleaning cost-effective heat exchanger materials with waterside configurations other than smooth and round. Experiment ation will be conducted at ANl using presently available equipment, with priority given to adapting commercial systems to OTEC applications. The resulting data will then be used for specifying further testing in a marine environment at the Seacoast Test Facility. In addition to measuring the effectiveness of the cleaning action, data will be taken on characteristics of the cleaning element, drive mechanism, cycle times, power requirements, and lifetime of the cleaning element. The overall goal of the program is to develop definitive design criteria which can be applied to actual OTEC installations.

29393 (CONF-810622—Vol.1, pp 403-408) **Microbiofouling of aluminum and titanium ocean thermal energy conversion (OTEC) evaporator tubes at a potential OTEC site.** Sasscer, D.S.; Morgan, T.O.; Tosteson, T.R.; Axtmayer, R.W.; Revuelta, R.; Imam, S.; Zaidi, B.R.; DeVore, D.; Ballantine, D.L. (Univ. of Puerto Rico, Mayaguez). Jun 1981. NTIS, PC A24.

From 8. ocean energy conference; Washington, DC, USA (7 Jun 1981).

Between 29 January 1980 and 10 March 1981, the Center for Energy and Environment Research of the University of Puerto Rico conducted a study of the biofouling of simulated OTEC evaporator tubes. The results of the study indicate that a base layer of bacteria and exudated polysaccharides enhances microbial adhesion and thereby creates an environment conducive to rapid biofilm groth. It is a superficial layer of dividing bacteria, however, which is largely responsible for the insulating properties of the biofilm. After the initial induction period, the fouling resistance of the polysaccharide layer was between 0.5 and 0.8 (15^{-4}), ft^2-hr-°F/Btu and the fouling rates were between 0.2 and 0.35 (10^{-4}) ft^2-hr-°F/Btu-Day.

29394 (CONF-810622—Vol.1, pp 409-413) **Microbial deposits, resistant to removal by the M.A.N. brush, on aluminum and titanium heat exchanger surfaces exposed to ambient seawater.** Tosteson, T.R.; Revuelta, R.; Imam, S.; Zaidi, B.R.; De Vore, D.; Ballantine, D.L.; Sasscer, D.S.; Morgan, T. (Univ. of Puerto Rico, Mayaguez). Jun 1981. NTIS, PC A24.

From 8. ocean energy conference; Washington, DC, USA (7 Jun 1981).

Microfouling on aluminum and titanium surfaces was analyzed during seven cleaning cycles covering 239 days. Microfouling was assessed immediately before and after cleaning the test surfaces. Prior to cleaning, peak thermal resistance and wet film thickness (WFT) on aluminum surfaces correlated. The titanium surface biomass (ATP) correlates with R/sub f/. Both phenomena may result in R/sub f/ increass due to immobilization of water. Cleaned titanium surfaces had measurable biomass. Clean aluminum surfaces had more organic carbon and larger C/N ratio than the clean tita-

nium. Differences between test surfaces,and their increasing R/sub f/ with time of exposure to seawater are discussed.

29395 (CONF-810622—Vol.1, pp 415-420) **Macrofouling in simulated OTEC evaporators at Punta Tuna, Puerto Rico.** Morgan, T.O.; Sasscer, D.S.; Rivera, C.J. (Univ. of Puerto Rico, Mayaguez). Jun 1981. NTIS, PC A24.

From 8. ocean energy conference; Washington, DC, USA (7 Jun 1981).

A biofouling study of simulated Ocean Thermal Energy Conversion (OTEC) evaporators was conducted at the potential OTEC site off Punta Tuna, Puerto Rico. When the 13 months study ended, the flow system was disassembled. A total of 61 species of benthic invertebrates representing 10 Phyla were found concentrated in areas of the flow system where there was a low rate of water exchange. Wherever an OTEC plant is sited, the potential for obstruction of the flow system by macrofouling organisms will probably exist. This problem must be taken into consideration in the design and operation of OTEC plants.

29396 (CONF-810622—Vol.1, pp 421-430) **Biofouling and corrosion stdies at Keahole Point, Hawaii (1978-1980).** Liebert, B.E.; Larsen-Basse, J.; Berger, J.A.; Berger, L.R. (Univ. of Hawaii, Honolulu). Jun 1981. NTIS, PC A24.

From 8. ocean energy conference; Washington, DC, USA (7 Jun 1981).

The nature of the biofouling and corrosion on heat exchanger pipes and their effect on heat transfer resistance (R/sub f/) was measured in experiments done at Keahole point, Hawaii over a three-year period. Seawater from about 1200 feet offshore was used in dummy heat exchangers placed in two locations: on a submerged buoy in the body of water itself and at the shore-based end of a 3-inch diameter polyvinyl chloride pipe about 1500 feet in length whose inlet was on the submerged buoy. R/sub f/ measurements were done with identical instruments in both locations. Biofouling and associated inorganic accretion are responsible for the increase in R/sub f/ with time observed in the corrosion-resistant titanium and stainless steel pipes. Inorganic products contribute partially to the increases in R/sub f/ observed in aluminum samples and are totally responsible for early changes for the copper-nickel alloy. However, all of the alloys biofoul in time. Brushing the pipe reduced the R/sub f/ values to near zero early in the experiment. Later, however, the same cleaning regime brought the R/sub f/ values to low but steadily increasingly positive values of R/sub f/. There are direct correlations between the amount of organic carbon, nitrogen, protein, and dry weight of the film and the R/sub f/ values in the titanium and stainless steel systems, but less clear correlation on aluminum. No correlations were observed between R/sub f/ and biofilms in the copper-nickel pipe. Results from the corrosion studies qualified both titanium and AL-6X stainless steel for use in OTEC warm water heat exchangers. Copper-nickel was found to corrode at an initial rate of about 75 μm/yr based on changes in film thickness. The corrosion rate of Alclad 3003 was greater than that of aluminum 5052, although both show decreasing rates with time. No pitting was found in any of the alloys.

29397 (CONF-810622—Vol.1, pp 431-436) **New flow cell technology for assessing primary biofouling in oceanic heat exchangers.** King, R.W.; Meyer, A.E.; Ziegler, R.C.; Baier, R.E. (Calspan Corp., Buffalo, NY). Jun 1981. NTIS, PC A24. Contract AC02-80ER10766.

From 8. ocean energy conference; Washington, DC, USA (7 Jun 1981).

The mitigation of biofouling by using coatings to adjust the energy state of flow surfaces to a range that might minimize permanent bioadhesion is studied. This early progress report describes the design and operating characteristics of simple and inexpensive flow cells that can be used in multiples to assess the early microfouling events for a large variety of material/water combinations. Incorporation of measurement technology for rapidly and repetitively determining the heat exchange retardation due to fouling, along with exceptional analytical sensitivity for compositional and thickness parameters of the built-up films still in place on the test surfaces, allows for explicit correlation of the fouling film characteristics with the important engineering parameters of heat transfer resistance.

29398 (CONF-810622—Vol.1, pp 439-445) **Preliminary environmental assessment of the OTEC pilot plant program.** Sullivan, S.M. (Interstate Electronics Corp., Anaheim, CA); Quinby-Hunt, M. Jun 1981. NTIS, PC A24. Contract W-7405-ENG-48.

From 8. ocean energy conference; Washington, DC, USA (7 Jun 1981).

An Environmental Assessment (EA) has been prepared for the deployment and operation of commercial 40-MWe Ocean Thermal Energy Conversion (OTEC) Pilot Plants. The generic EA evaluated the environmental issues associated with several candidate plant designs and siting locations, and found that several environmental impacts may potentially be associated with Pilot Plant operation. A site- and design-specific OTEC Pilot Plant Environmental Impact Statement (EIS) will be necessary to fully evaluate the magnitude of environmental effects. An overview of the OTEC 10/40 Pilot Plant Program is presented and potential environmental impacts are described. Data requirements necessary for resolving significant issues during preparation of future site- and design-specific Pilot Plant EIS's are identified and ranked in terms of priorities.

29399 (CONF-810622—Vol.1, pp 447-451) **Environmental assessment of the second deployment of mini-OTEC.** Donat, J.R. (Interstate Electronics Corp., Anaheim, CA). Jun 1981. NTIS, PC A24.

From 8. ocean energy conference; Washington, DC, USA (7 Jun 1981).

During its first deployment, Mini-OTEC became the first closed-cycle ocean thermal energy conversion (OTEC) plant to produce net energy at sea. Monitoring studies performed during the first deployment represent the first environmental data collected aboard an operating OTEC facility. Mini-OTEC is presently being considered for a second deployment for up to eighteen months. This paper sumarizes the environmental assessment (EA) of the proposed second deployment of Mini-OTEC. The results of the monitoring studies performed during the first deployment are reported. The environmental issues considered in the EA are identified and it is concluded that the second deployment will present no significant environmental impacts. Studies are recommended that should be performed during the second deployment to assist in estimating the environmental effects of larger scale OTEC projects. Finally, federal, state, and local permits required for the second deployment of Mini-OTEC are listed.

29400 (CONF-810622—Vol.1, pp 453-459) **Programmatic environmental impact statement on commercial OTEC licensing.** Myers, E.P. (National Oceanic and Atmospheric Administration, Washington, DC); Sullivan, S.M.; Donat, J.R. Jun 1981. NTIS, PC A24.

From 8. ocean energy conference; Washington, DC, USA (7 Jun 1981).

Commercial OTEC development may potentially affect the atmosphere, the terrestrial environment, and the marine ecosystem. The Ocean Thermal Energy Conversion Act of 1980 (PL 96-320) directs the Administrator of the National Oceanic and Atmospheric Administration (NOAA) to establish a licensing system which encourages commercial OTEC development and protects the marine environment and other ocean uses. An Environmental Impact Statement (EIS) was prepared that provides guidance regarding the types of environmental information that might be submitted with an OTEC license application and helps identify the research needs for an environmental research plan required by the OTEC Act of 1980. The EIS assessed the effects of commercial OTEC development to the year 2000 and evaluated regulatory alternatives for mitigating adverse environmental impacts.

29401 (CONF-810622—Vol.1, pp 461-466) **Ocean energy converter regulatory compliance monitoring: status and assessment.** Quinby-Hunt, M. (Univ. of California, Berkeley); Sands, M.D. Jun 1981. NTIS, PC A24.

From 8. ocean energy conference; Washington, DC, USA (7 Jun 1981).

The Federal Water Pollution Control Act, as amended, (FWPCA) established the National Pollutant Discharge Elimination System (NPDES) to regulate the point-source discharges to the

nation's surface waters. In compliance with the FWPCA, Region IX of the US Environmental Protection Agency issues NPDES permit number HI 0110272 to the Department of Energy for the converted T2 tanker Chepachet (renamed to Ocean Energy Converter, OEC). The NPDES permit recognized several discharges and specified both discharge limitations and monitoring requirements for several parameters on and around the platform. The preliminary results from the monitoring program will be compared to both available historical data and to the predictions in the OTEC-I Environmental Assessment.

29402 (CONF-810622—Vol.1, pp 467-474) **Near-field physical model studies of OTEC mixing and recirculation.** Adams, E.; Fry, D.; Coxe, D.; Kubiak, D.; Singarella, P. (Massachusetts Inst. of Tech., Cambridge). Jun 1981. NTIS, PC A24.

From 8. ocean energy conference; Washington, DC, USA (7 Jun 1981).

A physical model study has been ongoing to investigate the sensitivity of recirculation and near field plume dynamics to variations in OTEC plant design and ambient ocean conditions. Tests have focussed on large (200 to 600 MWe) and pilot scale (10 to 80 MWe) deep water floating plants. However, certain aspects of the results, as well as results reported in previous studies are also relevant to shelf-mounted or shore-based designs. This paper briefly reviews past and present experimental studies and reports on results.

29403 (CONF-810622—Vol.1, pp 475-482) **Intermediate field plumes from OTEC plants: predictions for typical site conditions.** Jirka, G.H.; Jones, J.M.; Sargent, F.E. (Cornell Univ., Ithaca, NY). Jun 1981. NTIS, PC A24. Contract AC02-78ET20483.

From 8. ocean energy conference; Washington, DC, USA (7 Jun 1981).

In the intermediate field of OTEC induced dynamical perturbations in the ambient stratified ocean the effluents are distributed horizontally in a shallow layer or several layers. This paper applies the intermediate field model to typical OTEC designs (OTEC-100 and OTEC-1) at ocean sites that are under consideration in the current DOE program. For large OTEC plants the intermediate field has a large horizontal extent (of order 10 km) with a limited layer thickness (of order 10 m). The ocean current has a dramatic influence on intermediate field behavior. Changes in ambient stratification and near-field mixing show a much smaller sensitivity. The characteristic time scale for intermediate field responses is of the order of several hours. Results for the pilot scale, OTEC-1, show that the intermediate field is comparatively limited with a typical width of aobut 100 m at 1 km downstream from the source. Implications for further modeling, design of environmental monitoring programs and bio-chemical transformations are discussed.

29404 (CONF-810622—Vol.1, pp 483-494) **Some results from a three-dimensional Gulf of Mexico circulation model.** Blumberg, A.F.; Mellor, G.L. (Dynalysis of Princeton, NJ). Jun 1981. NTIS, PC A24. Contract AC02-78ET20612.

From 8. ocean energy conference; Washington, DC, USA (7 Jun 1981).

A three-dimensional, time-dependent prognostic model has been developed and applied ot the Gulf of Mexico. The model is driven by winds and surface heat flux derived from climatological, atmospheric surface data. Mean velocity, surface elevation, temperature, salinity, turbulence kinetic energy and turbulence macroscale are the prognostic variables. A full year's simulation has been obtained and the results feature a Loop Current with a seasonal cycle and a persistent anticyclonic gyre in the western portion of the Gulf. No eddy shedding has occurred. Comparison with observational data indiate that the model can reproduce the large scale features of the circulation such as the variability, intensity and areal extent of the major current systems.

29405 (CONF-810622—Vol.1, pp 495-501) **Circulation study of the Western Florida Shelf.** Cooper, C.; Humphreys, A.H. III. (New England Coastal Engineers, Inc., Bangor, ME). Jun 1981. NTIS, PC A24.

From 8. ocean energy conference; Washington, DC, USA (7 Jun 1981).

The primary purpose of the study is to develop a numerical circulatoin model which can provide accurate current velocities for oil spill impact assessment. Besides the relevance to other sites of potential offshore petroleum development, the study which is described is also pertinent to calculation of currents during extreme storm events, a problem of particular interest in design and construction of offshore structures including OTEC plants. The paper describes the West Florida Shelf Study and summarizes the existing oceanographic and meteorologic data which has been identified and archived during the study. Some of the mechanisms which govern flow in te region are identified and discussed. The 3-dimensional model used in the study is briefly described as are the modeling techniques that are to be used in upcoming phases of the study.

29406 (CONF-810622—Vol.1, pp 503-504) **Physical variability of island circulation.** Wang, D.P. (Argonne National Lab., IL). Jun 1981. NTIS, PC A24.

From 8. ocean energy conference; Washington, DC, USA (7 Jun 1981).

Historical data and the OTEC-1 environmental mesurements both indicated large current fluctuations in Hawaii Islands in time scales of hours to months. Based on these results, a perspective on the processes and mechanisms of variability is sought. The objective is to make a preliminary characterization of the dynamic features which must be accounted for in models of island circulation. The relation of the physical variability of island circulation to the structural design and plume dispersion of OTEC plants is also discussed.

29407 (CONF-810622—Vol.1, pp 527-535) **Effects of chemical pollutants from the OTEC plants on Mugil cephalus.** Venkataramiah, A. (Gulf Coast Research Lab., Ocean Springs, MS); Lakshmi, G.J.; Best, C.; Gunte, G.; Hartwig, E.; Wilde, P. Jun 1981. NTIS, PC A24. Contract AS02-78ET20512.

From 8. ocean energy conference; Washington, DC, USA (7 Jun 1981).

In these acute and chronic bioassays, the OTEC working fluids, ammonia and chlorine, were the source of the toxicants. Mugil cephalus were used as experimental animals. The sublethal, lethal and incipient lethal ranges of ammonia and chlorine were determined from the 96 hr studies. LC_{50} and LT_{50} values increased linearly with increased weight of mullet. LT_{50} values were, however, inversely related to the toxicant concentrations. In chronic studies the level of activity, food consumption and growth rates of mullet in the sublethal concentrations were nearly identical to controls. With increased toxic levels mullet experienced greater stress and higher mortality and showed avoidance response away from high toward low concentrations.

29408 (CONF-810622—Vol.1, pp 547-550) **Marine geologic data at OTEC sites.** Chase, T.E.; Normark, W.R.; Wilde, P. Jun 1981. NTIS, PC A24. Contract W-7405-ENG-48.

From 8. ocean energy conference; Washington, DC, USA (7 Jun 1981).

The knowledge of the characteristics of the sea-bed and seafloor are important to the success of the OTEC program from both an engineering (anchoring cableway, foundation, etc.) and an environmental perspective. The Marine Geology Branch of the US Geological Survey in cooperation with the Lawrence Berkeley Laboratory are providing marine geologic information to the OTEC program in four broad categories: archival studies and working base map preparation, geophysical and geotechnical investigations at sites, laboratory measurements, and liaison and advisory services. The major efforts to date have been preparation of regional marine geologic data sheets for the Hawaiian Islands and the Puerto Rico-Virgin Islands areas. Such data sheets include, at a minimum, a bathymetric base map (100 meter contour interval) with lists of applicable navigation charts pertinent references, sources and data contacts, maps of geographic features, bottom sample locations, earthquake epicenters, gravity and magnetic anomalies, sea surface temperatures, and drift (monthly) and track lines of geophysical cruises, and selected profiles of subbottom records. Additional data sheets are planned for Guam/N. Marianas and the Gulf of Mexico, and have been proposed for seven other

potential OTEC areas. The regional data sheets are a preliminary step in defining areas where specific OTEC options are feasible. Pre-deployment site specific geologic/geophysical data, in general, is not available. Accordingly, on a ship of opportunity basis, data collection cruises are planned for target OTEC sites. The inital cruise of this series was to the Kahe Point, Oahu, Hawaii site in early 1981.

29409 (CONF-810622—Vol.1, pp 551-563) **Environmental description requirements for OTEC plants loading design.** Giannotti, J. (Giannotti & Associates, Inc., Annapolis, MD); Vega, L. Jun 1981. NTIS, PC A24.

From 8. ocean energy conference; Washington, DC, USA (7 Jun 1981).

The design oriented analysis of an OTEC plant must consider both Survivability Design Loads and Operational/Fatigue Design Loads. The first kind of plant loading is based on extreme environmental phenomena, with a long return period, that might result in ultimate strength failure while the second kind might result in fatigue induced failure through normal operations. The meteorological, sea surface, water column and sea floor descriptions required to determine both kinds of loading for each major OTEC subsystem are established by considering design processes. The environmental information necessary to establish survivability loading is available for most OTEC potential sites. However, for operational loading determination, the information is not available or is incomplete. Site specific environmental data must be obtained. Data gathering efforts being carried out for the OTEC program, at present, are not design oriented. Such programs could and should be updatd. In addition, participation in such efforts by other agencies must be sought. A program to remotely gather data required for the determination of the operational exposure is described. Range, accuracy, minimum sensor positioning and the minimum data-recording frequency are tabulated.

29410 (CONF-810622—Vol.1, pp 565-573) **Structure of the ocean off Punta Tuna, Puerto Rico in relation to OTEC.** Lopez, J.M.; Yoshioka, P.M.; Gonzalez, J.G.; Capella, J.E.; Fornshell, J.A.; Barbot, J.A.R. (Center for Energy and Environment Research, Mayaguez, Puerto Rico). Jun 1981. NTIS, PC A24.

From 8. ocean energy conference; Washington, DC, USA (7 Jun 1981).

The sea, south of Puerto Rico, shows variability in the upper 200 m, surface salinity varying from 34.2 to 3.67% and temperatures from 26° to 29.5°C. The maximum salinity ad minimum temperatures occur during winter and minimum salinity with maximum temperature during summer. Below 200 m the variability due to internal waves increases and is the most significant factor at 1000 m. Long-term variations in the temperature fields have a frequency on the order of four months. The current system is predominantly a westward drift with the occurrence of occasional eddies and meanders. Ecological processes in this ocean appear to occur on small spatial scales as no large scale patterns were observed.

1409 Solar Thermal Utilization

REFER ALSO TO CITATION(S) 29418, 29806

29411 (DOE/CH/10122—13) **Project status report on field research tasks and technical services, December 1, 1982-February 28, 1983.** (ESG, Inc., Atlanta, GA (USA)). Mar 1983. Contract AC02-82CH10122. 69p. NTIS, PC A04/MF A01. Order Number DE83010221.

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Relative to Field Measurement, Analyses, and Reporting Related to Building Energy Systems and Biomass Projects, sound progress continued on monitoring of 8 priority Class B sites. Attention is being given to initial data analysis, including basic comparison with other field work. Site documentation is being developed while working with the day-to-day instrumentation upgrades and data collection tasks. Major work has been completed on the SLR-Plus analysis tool, including near completion of the algorithm reference manual. Work is continuing on improved techniques for handling mass walls with particular attention to cooling load interactions. Analysis of performance results of domestic hot water monitoring program results and major reporting tasks are covered. Technology transfer efforts for industry and other special applications was continued to the extent feasible. This work was at a relatively low level of effort. Good progress is being made on Technical Services in Support of Appropriate Technology Program. Twenty-nine additional project files were received at ESG, bringing the total for review to 85. A large percentage of the initial review work has been completed. Seven selected site visits were made, and appropriate telephone monitoring continued. A presentation on project activities was made for a meeting involving state energy office personnel in the region involved.

29412 (DOE/CS/34090—T1) **Analysis of performance of the passive-solar-heated Patoka Nature Center, Birdseye, Indiana. Final project report.** (Miami Univ., Oxford, OH (USA). Dept. of Architecture). 22 Nov 1982. Contract FG04-77CS34090. 77p. NTIS, PC A05/MF A01. Order Number DE83009529.

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The purpose of this project was to monitor and analyze the passive-solar-heating performance of Patoka Nature Center. Patoka Nature Center is located in southern Indiana. The building has a floor area of 3200 square feet, is heavily bermed and well-insulated. The building features 1390 net square feet of direct-gain solar collector. This collector is equipped with BEADWALL (tm) night insulation. Thermal storage is provided by a masonry floor and 40 water-filled fiberglass tubes. The building's thermal performance was monitored from July 15, 1981 until July 17, 1982. During the 1981-1982 heating season, the subject building used 257 million BTUs for space heating. This was supplied from: auxillary heating equipment (28%), electric lighting (22%), other equipment (2%), and solar (48%). The annual solar heating efficiency (solar utilized/solar incident on collector glass) was 21.9%.

29413 (EUR—8134-EN/FR) **Solar heating of plant's sanitary water. Final report.** Plumat, R. (Glaverbel, Fleurus (Belgium)). 1982. 132p. (In English and French). European Communities Information Service, 2100 M Street NW, Suite 707, Washington, DC 20037.

The results are given of a first year of demonstration period of a sanitary-water solar-heating plant for an industrial complex. The architectural integration of solar collectors in front of the building is a success. Interesting records upon the differences of temperatures of solar-collector flat-cover glass and its distension strains were obtained. Good results are reported as regards the solar supply: 56.87% of the real needs. Expected needs of hot water were overestimated with a consumption near to zero during the yearly holidays. Owing to that fact the plant works at 40% of its expected capacity, negative influence (boiler thermically full) for the whole productivity and for the unit cost (solar kWh) were experienced. Concerning saving by reinforcer mirrors, insufficient information exists but at first sight the factors of necessary areas and getting dirty of the mirrors should condition and limit the use.

29414 (EUR—8166-EN) **Solar Pilot Test Facility. Final report.** Balslev-Olesen, O. (Danmarks Tekniske Hoejskole, Lyngby). 1982. 66p. European Community Information Service, 2100 M Street, NW, Suite 707, Washington, DC 20037.

This report describes the results achieved during the two heating seasons 79/80 and 80/81 by the Danish participants of the solar pilot test facility group. Nine installation descriptors for nine different operation sequences are prepared with reference to model validation. Special experiments are performed to get more accurate values of the system parameters. Data descriptors are prepared with an indication of the uncertainty of the measurements. With the Danish solar simulation program and the Danish test reference year as input the system performance is predicted. From the simulations it was evident that the system performance could be improved by changing some of the system parameters. The system therefore has been changed, and detailed descriptions of the modifications are included. The efficiency curves of the collectors used at the Danish solar pilot test facilities are obtained by measurements and compared with laboratory test results.

29415 **(NMERDI—2-68-2131) Demonstration of a retrofit solar heating system on the Jemez Pueblo Civic Center.** Edgel, W.R. (New Mexico Engineering Research Inst., Albuquerque (USA)). Feb 1983. Contract FG46-80R612026. 53p. NTIS, PC A04/MF A01. Order Number DE83008656.

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This project consisted of designing and constructing thermal envelope improvements, a retrofit Trombe wall, and a domestic hot-water preheater on the Jemez Pueblo Civic Center, an 11,000-square foot masonry building which houses a gymnasium, classrooms, and the tribal offices. The purpose of this project was to demonstrate the applicability of retrofit solar-heating systems to large buildings owned by local governments in remote areas of the state. Preliminary estimates indicated that the proposed retrofit installation would reduce the fuel consumption of the subject building substantially. After construction, the fuel consumption of the building was monitored to measure the actual fuel and cost savings, which are projected to be nearly 50 percent.

29416 **(SERI/TR—254-1805) Evaluation and laboratory testing of solar domestic-hot-water control systems.** Farrington, R.B.; Myers, D. (Solar Energy Research Inst., Golden, CO (USA)). Feb 1983. Contract AC02-77CH00178. 82p. NTIS, PC A05/MF A01. Order Number DE83010896.

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This report was to encourage solar domestic hot water (SDHW) control system manufacturers, designers, and researchers to improve the reliability and performance of SDHW systems. It contains an assessment and evaluation of solar domestic hot water (SDHW) control systems with respect to reliability and performance. A review of the literature and test results agree that serious problems still exist with current SDHW control systems. The literature review presents results gleaned from other sources; these and SERI's test results demonstrate the magnitude of SDHW control system problems. The tests revealed problems with sensor accuracy, sensor stagnation failures, controller accuracy, heat and humidity effects, long-term electronics, failure to meet specifications, poor instructions, and incorrect color-coding of wires. This work also identifies areas requiring further testing and evaluation. The report also presents a low-cost approach to detecting critical SDHW system failures (e.g., of pumps, valves, sensors and controllers, and piping, and failures due to critical heat transfer fluid losses). Further work is needed to build and test the system.

29417 **Thermal performance of solar systems in the National Solar Data Network.** Rossi, S.M. (Vitro Lab). pp 341-349 of Advances in energy utilities technology. Atlanta, GA; Fairmont Press Inc. (1981).

From 4. world engineering congress; Atlanta, GA, USA (12 Oct 1981).

Performance results are presented from thirty-three sites in the National Solar Data Network. These sites are being monitored throughout the country and have domestic hot water, space heating and/or space cooling applications. The solar fraction and energy savings are discussed in detail for each application. Various ratios of load to a specific parameter are also used for comparison. Also particular sizing parameters used for some of the sites are discussed. The National Solar Data Network is a data bank of system performance factors for solar sites. For the past four years, data has been obtained on a 24-hour basis.

1410 Solar Collectors And Concentrators

REFER ALSO TO CITATION(S) 29323, 29324

29418 **(ALO—5366-4) Forced- and natural-convection studies on solar collectors for heating and cooling applications. Final report.** Pearson, J.T. (Purdue Univ., Lafayette, IN (USA). Heat Transfer Lab.). Mar 1983. Contract AC04-78CS35366. 126p. NTIS, PC A07/MF A01. Order Number DE83009863.

An experimental and analytical study has been conducted on convection in air-heating solar collectors for heating and cooling applications. During the first phase of the investigation, literature and technology surveys were conducted which determined that improvement in the overall conductance between the absorber and the flowing air was an area that needed much improvement. Theoretical and experimental studies were then performed to obtain several absorber-convector configurations which have superior heat transfer performance, modest pressure drop penalties, and a high potential for economical manufacturing. Four surfaces which may be fabricated from aluminum or steel are recommended. Three utilize corrugated sheets bonded to the backplate and/or the back side of the absorber. These three surfaces are recommended for applications where airflow behind the absorber is appropriate. For those applications where airflow above the absorber is appropriate, a louvered surface which can be fabricated from metal or plastic is recommended.

29419 **(CONF-830316—2) Status of black chrome coating research.** Pettit, R.B.; Sowell, R.R. (Sandia National Labs., Albuquerque, NM (USA)). 1983. Contract AC04-76DP00789. 13p. NTIS, PC A02/MF A01. Order Number DE83008182.

From Distributed solar collector conference; Albuquerque, NM, USA (15 Mar 1983).

Recent results regarding the optimization of electrodeposited black chrome solar selective coatings for operation in solar collectors to temperatures up to 300°C are summarized. Careful control of the electroplating-bath composition and special regard for bath contamination are required in order to obtain coatings that will survive daily collector operation for tens of years. An accelerated temperature aging test is presented which can be used both to estimate the coating lifetime and to monitor the coating during production. Finally, the use of sol-gel protective films to extend the lifetime of the black chrome coating is also discussed.

29420 **(DOE/AL/13121—T1) Development of a focusing solar-collector energy-conversion system. Final report.** Rogers, W.E.; Borton, D.N. (Dun and Bradstreet Corp., Parsippany, NJ (USA); Rensselaer Polytechnic Inst., Troy, NY (USA). Dept. of Mechanical Engineering, Aeronautical Engineering and Mechanics). 1 Oct 1980. Contract FG04-80AL13121. 66p. NTIS, PC A04/MF A01. Order Number DE83010889.

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This research set out to develop a solar collector which would produce unique engineering gains in the collection of solar energy in the Northeast. Such a collector, if made cost-competitive with fossil or other fuels imported to this state, for energy delivered, would merit the attention of the energy users in this part of the country. Control of the design sophistication in hardware components became the primary focus in carrying out the objectives of this proposed work. Many criteria were considered in both choosing a concentrator configuration and its size. After analyzing off-axis focusing aberration, reflector shading and blocking, total available incident insolation, and mechanical aspects, a turntable collector oriented south, was selected. The reflector columns in this design rotate to follow altitude changes of the sun. A solar collector package consisting of a concentrating reflector, a cavity boiler receiver with fluxtrap and a programmable control system has evolved and been built. The final unit is an automated system which delivers 250 degrees F steam at a 70 kilowatt rate within one minute of turning the system on, has been developed, manufactured and fully tested. Engineering research tasks which have been completed include mechanical aspects of the design, performance testing and cost analysis of the concentrator array; receiver design alternatives including various configurational schemes and materials testing; system integration and control, and investigation of production techniques for various components of the system.

29421 **(SAND—82-7039) Glass/space frame solar-collector development.** Biester, A.W. (Budd Co., Fort Washington, PA (USA). Technical Center). Mar 1983. Contract AC04-76DP00789. 60p. NTIS, PC A04/MF A01. Order Number DE83009002.

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The development, fabrication, and testing of space frame solar collectors utilizing six millimeter thick pre-formed glass mirrors as structural and reflective members are described.

29422 (SAND—82-7068/1) **Environmental degradation of solar optical materials. Volume 1. Literature survey.** Morris, V.L. (McDonnell Douglas Astronautics Co., Huntington Beach, CA (USA)). Nov 1982. Contract AC04-76DP00789. 127p. NTIS, PC A07/MF A01. Order Number DE83010298.

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Exposure of solar optical materials to real use environments results in both physical degradation (soiling and abrasion) and chemical degradation (corrosion) of the material. These effects can decrease the appropriate optical property of the material and result in diminished solar system operating efficiency. The ultimate result is an increased cost for the energy produced, thus diminishing the viability of solar energy as a competitor in the energy market. Considerable research has been conducted in the areas of evaluating degradative mechanisms and monitoring the realtime effects of exposing these materials to typical solar system environments. A review of available literature on the environmental degradation of solar optical materials, exposed to real or simulated solar use environments, is summarized. Emphasis was placed on the physical and chemical degradative effects of the exposure environment on the optical materials proposed for or used in active solar energy systems. The optical materials investigated were both transmitting and reflecting. Additionally, techniques for monitoring degradation effects and methods for evaluating the appropriate optical properties are reviewed.

1420 Heat Storage

29423 **Entirely passive heat pipe apparatus capable of operating against gravity.** Koenig, D.R. (to Dept. of Energy). US Patent 4,336,837. 29 Jun 1982. Filed date 11 Feb 1981. vp.

PAT-APPL-233365.

The disclosure is directed to an entirely passive heat pipe apparatus capable of operating against gravity for vertical distances in the order of 3 to 7 meters and more. A return conduit into which an inert gas is introduced is used to lower the specific density of the working fluid so that it may be returned a greater vertical distance from condenser to evaporator.

15 GEOTHERMAL ENERGY

29424 (DOE/ET/28365—T3) **Bibliography of geothermal reports in Colorado. Bulletin 44.** Pearl, R.H.; Zacharakis, T.G.; Repplier, F.N.; McCarthy, K.P. (Colorado Geological Survey, Denver (USA)). 1981. Contract AS07-77ET28365. 27p. NTIS, PC A02/MF A01. Order Number DE83010373.

This bibliography comprises all known published and unpublished public reports pertaining to the geothermal resources of Colorado through 1980. The report is in two alphabetical sections, BIBLIOGRAPHY and SUBJECT INDEX. The Bibliography section is a listing of the various authors with key works, while the Subject Index section is a listing of the various authors by subject.

29425 (EPRI-AP—2760, pp 4.1-4.3) **Program manager's perspective.** Roberts, V.W. (Electric Power Research Inst., Palo Alto, CA). Dec 1982. NTIS, PC A13/MF A01.

From 6. annual geothermal conference; Snowbird, UT, USA (29 Jun 1982).

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EPRI and its geothermal program are described briefly. The research and development areas and program objectives are listed. The subprogram structure is described, as follows: binary cycle development, wellheads systems development, subsystems development, geothermal fluid chemistry, and advanced geothermal systems. (MHR)

29426 (EPRI-AP—2760, pp 4.13-4.15) **Research and Development Projects: geothermal power systems.** Dec 1982. NTIS, PC A13/MF A01.

From 6. annual geothermal conference; Snowbird, UT, USA (29 Jun 1982).

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29427 (EPRI-AP—2760, pp 8.12) **Resource company perspective on shortening the time to power on line.** Harban, D.C. (Phillips Petroleum Co., Salt Lake City, UT). Dec 1982. NTIS, PC A13/MF A01.

From 6. annual geothermal conference; Snowbird, UT, USA (29 Jun 1982).

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The DOE's geothermal programs are reviewed and the activities of other Federal agencies are mentioned. The following are discussed: research and development in Geothermal and Hydropower Technologies Division, the Loan Guarantee and Interest Assistance Program, and geothermal R and D in the Geoscience Program of the Office of Energy Research. (MHR)

29428 (SAND—83-0492) **Geothermal technology publications and related reports: a bibliography, January-December 1982.** Hudson, S.R. (ed.). (Sandia National Labs., Albuquerque, NM (USA)). Mar 1983. Contract AC04-76DP00789. 44p. NTIS, PC A03/MF A01. Order Number DE83010416.

This bibliography extends the past listings to work reported in the 1982 calendar year. Titles, authors and abstracts of papers are assembled into areas of Geothermal Technology and Magma with cross references listed by author.

1501 Resource Status And Assessment

REFER ALSO TO CITATION(S) 29469

29429 (DOE/ID/12015—T1) **Geothermal resources in Arizona: a bibliography. Circular 23.** Calvo, S.S. (Arizona Univ., Tucson (USA). Bureau of Geology and Mineral Technology). 1982. Contract FC07-79ID12015. 25p. NTIS, PC A02/MF A01. Order Number DE83010806.

All reports and maps generated by the Geothermal Project of the Arizona Bureau of Geology and Mineral Technology and the Arizona Geothermal Commercialization Team of the University of Arizona are listed. In order to provide a more comprehensive listing of geothermal papers from other sources have been included. There are 224 references in the bibliography. (MHR)

29430 (EPRI-AP—2760, pp 3.27-3.29) **Milford geothermal No. 1, Roosevelt Hot Springs KGRA.** Brown, D.R. (Utah Power and Light Co., Salt Lake City). Dec 1982. NTIS, PC A13/MF A01.

From 6. annual geothermal conference; Snowbird, UT, USA (29 Jun 1982).

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Some historical material on geothermal development, in general, and Roosevelt Hot Springs, in particular, is presented. The potential geothermal development at the Roosevelt Hot Springs area in southwestern Utah and the current activities of Utah Power and Light in furthering this development are discussed. (MHR)

29431 (EPRI-AP—2760, pp 6.69-6.70) **Perspectives on geothermal development in Mexico.** Nieva, D. (Instituto de Investigaciones Electricas, Cuernavaca, Mor., Mexico). Dec 1982. NTIS, PC A13/MF A01.

From 6. annual geothermal conference; Snowbird, UT, USA (29 Jun 1982).

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1502 Geology And Hydrology Of Geothermal Systems

REFER ALSO TO CITATION(S) 29435

1503 Geothermal Exploration And Exploration Technology

REFER ALSO TO CITATION(S) 29471

29432 **(DOE/CE—0009/7) Geothermal progress monitor. Progress report No. 7.** (USDOE Assistant Secretary for Conservation and Renewable Energy, Washington, DC). Apr 1983. 184p. NTIS, PC A09/MF A01. Order Number DE83011213.

A state-by-state review of major geothermal-development activities during 1982 is presented. It also inlcudes a summary of recent drilling and exploration efforts and the results of the 1982 leasing program. Two complementary sections feature an update of geothermal direct-use applications and a site-by-site summary of US geothermal electric-power development.

29433 **(DOE/ET/27111—9) Microseismic monitoring of Chocolate Bayou, Texas. The Pleasant Bayou No. 2 geopressured/geothermal energy test-well program. 1982 annual progress report.** Mauk, F.J.; Davis, R.A. (Teledyne Geotech, Garland, TX (USA)). 1982. Contract AC08-79ET27111. 120p. NTIS, PC A06/MF A01. Order Number DE83011037.

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To investigate the seismic risks associated with geopressured fluid production from the Pleasant Bayou No. 2 design well a seismic monitoring program was conducted in the vicinity of the Brazoria County design wells since 1979. The monitoring program was designed first to establish the nature of the local ambient seismicity prior to production, and second to provide continued surveillance of the area during the well tests to determine if production altered ambient seismic conditions significantly. The operation, data analyses, results and conclusions of the Brazoria seismic network during the operational period from 1 January through 31 December 1982 are described.

29434 **(DOE/ID/12079—80) Multielement geochemistry of three geothermal wells, Cove Fort-Sulphurdale geothermal area, Utah.** Christensen, O.D. (Utah Univ., Salt Lake City (USA). Research Inst.). Sep 1982. Contract AC07-79ID12079. 51p. (ESL—101). NTIS, PC A04/MF A01. Order Number DE83008657.

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Multielement geochemical analysis of drill cuttings from three geothermal wells, Utah State 42-7, Utah State 31-33 and Forminco No. 1, in the Cove Fort-Sulphurdale KGRA, Utah, demonstrates that the distributions of different elements are the result of different chemical processes operating throughout the geologic history of the area. Statistical analysis of geochemical-data distributions confirm the presence of several distinct element associations. Of the 36 elements determined on the samples, 12 (V, Mo, Cd, Ag, Au, Sb, Bi, U, Te, Sn, B and Th) were present in concentrations at or below detection levels. Of the remaining 24 elements, only 3 (Ni, Co and Zr) are lognormally distributed. Distributions for the remaining elements are of aggregate populations which represent background, mineralization or other processes.

29435 **(DOE/RA/50272—T1) Geothermal resource assessment of the New England states.** Brophy, G.P. (Amherst Coll., MA (USA)). 1982. Contract FC07-80RA50272. 74p. NTIS, PC A04/MF A01. Order Number DE83010022.

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With the exception of Sand Springs in Williamstown, Massachusetts, there are no identifiable hydrothermal geothermal resources in the New England region. The radioactive plutons of the White Mountains of New Hampshire do not, apparently, contain sufficient stored heat to make them a feasible target for an induced hydrothermal system such as exists at Fenton Hill near Los Alamos, New Mexico. The only potential source of low grade heat is the large volume of ground water contained within the unconsolidated sediments related to the Pleistocene glaciation of the region. During the course of the survey an unusual and unexplained thermal anomaly was discovered in St. Johnsbury, Vermont, which is described.

29436 (EPRI-AP—2760, pp 3.10-3.14) **Meager Creek geothermal exploration update.** Stauder, J. (British Columbia Hydro, Vancouver). Dec 1982. NTIS, PC A13/MF A01.

From 6. annual geothermal conference; Snowbird, UT, USA (29 Jun 1982).

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During 1981/82, B.C. Hydro embarked on the final exploration stage at the Meager Creek Geothermal Area (South Reservoir), and also continued on the early exploration work on the north flanks of the Meager Volcanic Complex (North Reservoir). The work done in the South Reservoir area advanced the understanding of the structural controls for geothermal fluid movements and thus improved well siting capabilities. In the North Reservoir, the area of the headwaters of Job and Affliction Creeks has been outlined as a future exploration target. The work included: deep well drilling and testing, measurements and preliminary evaluation of wells drilled, diamond drilling, resistivity surveys and geochemistry and stream conductivities.

29437 (EPRI-AP—2760, pp 3.18-3.20) **Geothermal plans: Los Angeles Department of Water and Power.** Sugine, S.S. (Los Angeles Dept. of Water and Power, CA). Dec 1982. NTIS, PC A13/MF A01.

From 6. annual geothermal conference; Snowbird, UT, USA (29 Jun 1982).

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An overview and status of the Los Angeles Department of Water and Power's (Department) geothermal program which consists of the North Brawley Geothermal Project and the Coso Geothermal Project are presented.

29438 (EPRI-AP—2760, pp 7.17-7.21) **IIE geothermal research program: collaboration with EPRI.** Mulas, P. (Instituto de Investigaciones Electricas, Cuernavaca, Morelos, Mexico). Dec 1982. NTIS, PC A13/MF A01.

From 6. annual geothermal conference; Snowbird, UT, USA (29 Jun 1982).

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The Mexican research activities carried out in this program are discussed in three main areas: exploration, field development, and field and plant operation. (MHR)

29439 **(PNL—4613) Detailed conceptual design of a high-temperature CO_2 sensor for geothermal applications. Final report, Task I.** Phelan, D.M.; Taylor, R.M.; Baxter, R.D. (Leeds and Northrup Co., North Wales, PA (USA)). Mar 1983. Contract AC06-76RL01830. 160p. NTIS, PC A08/MF A01. Order Number DE83010843.

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The work performed on the development of a pCO_2 probe is documented. The recommended probe includes a solid state device which senses the pH of the internal electrolyte, a gas-permeable membrane that allows diffusion of CO_2 into the electrolyte, and a getter to inhibit incursion of H_2S. The results of the feasibility study indicate that such a probe holds promise of meeting all the operational and environmental requirements for in situ and downhole measurement of carbon dioxide in geothermal fluids.

1504 Legal And Institutional Aspects

REFER ALSO TO CITATION(S) 29429

29440 (EPRI-AP—2760, pp 6.25-6.34) **Geothermal energy development in Japan.** Hirose, Y. (Ministry of International Trade and Industry, Tokyo, Japan). Dec 1982. NTIS, PC A13/MF A01.

From 6. annual geothermal conference; Snowbird, UT, USA (29 Jun 1982).

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The following are discussed: Japan's energy situation, alternative energy development and targets for geothermal development, promotion of geothermal energy development, and constraints on geothermal energy development and policy measures.

29441 (EPRI-AP—2760, pp 8.3-8.5) **Negotiating a geothermal fluid supply contract.** Roberts, R.L. (Hanna and Morton, Los Angeles, CA). Dec 1982. NTIS, PC A13/MF A01.

From 6. annual geothermal conference; Snowbird, UT, USA (29 Jun 1982).

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Issues involved in negotiating a contract are discussed as follows: understanding the economics of the other party; understanding the legal structure of the other party; assessing and allocating risk before negotiating price; always having legal title to resources which are in your possession; providing some reasonable level of protection from non-performance to the other party; and not placing regulatory risk on the resource developer. (MHR)

1506 Environmental Aspects And Waste Disposal

29442 (EPRI-AP—2760, pp 6.18-6.24) **New Zealand: an update on reinjection experience.** Horne, R.N. (Stanford Univ., CA); Grant, M.A. Dec 1982. NTIS, PC A13/MF A01.

From 6. annual geothermal conference; Snowbird, UT, USA (29 Jun 1982).

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Extensive injection testing has been carried out in recent years in New Zealand in the process of designing a reinjection scheme for upcoming Ohaki (Broadlands) geothermal field development. In addition, there have been a number of long-term injections at Wairakei. Actually, all were unintentional arising from downflowing colder water within certain wells; however, much valuable information was obtained. The results summarized fall into three categories of interest: permeability changes due to injection (both increases and decreases have been observed); tracer returns from injection wells to other producers; and thermal influence of injection on the injection well itself and on its surrounding producers.

29443 (LA—9479-PR, pp 132-134) **Predicting brine spillage from hydrothermal energy electrical development.** Williams, J.M.; Hersman, L.E.; Langhorst, G.J.; Lujan, C. Oct 1982. NTIS, PC A08/MF A01.

In Los Alamos Life Sciences Division's biomedical and environmental research programs. Progress report, January-December 1981.

A major concern in the development of hydrothermal energy is the accidental discharge of brines into the environment. Such discharges were postulated to subject the exposed ecosystems to hot saline water which could also contain toxic elements. Concern was expressed that these releases might adversely affect soils, plants, and nearby water systems. As part of a multilaboratory effort to address environmental issues attendant to developing hydrothermal energy, Los Alamos has undertaken the task of evaluating the effects that might result from the acute conditions created by a brine spill. This report briefly describes one of the necessary first efforts needed to describe and define spill effects, i.e., to provide a prediction of the kinds and size of spills and how often they occur.

29444 (LA—9479-PR, pp 138) **Comparative winter nutrition of elk in the Jemez Mountains, New Mexico.** Rowland, M.M.; Alldredge, A.W.; Ellis, J.E.; White, G.C. Oct 1982. NTIS, PC A08/MF A01.

In Los Alamos Life Sciences Division's biomedical and environmental research programs. Progress report, January-December 1981.

Winter ranges of the Jemez Mountain Elk include proposed geothermal sites. Knowledge of winter range qualities associated with nutritional status of elk may assist in mitigation of potential losses of habitat due to energy resource development. For this reason, a study of winter diet quality and nutritional status of elk was conducted in the Jemez Mountains, New Mexico concentrating on the botanical composition of elk diets. (DLS)

29445 (LBL—14605) **Physical processes of subsidence in geothermal reservoirs.** Schatz, J.F. (Terra Tek, Inc., Salt Lake City, UT (USA)). Jun 1982. Contract AC03-76SF00098. 151p. (GSRMP—12). NTIS, PC A08/MF A01. Order Number DE83011017.

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The objectives of this project were to acquire core and fluid from producing geothermal reservoirs (East Mesa, United States, and Cerro Prieto, Mexico); to test specimens of this core for their short-term and long-term (creep) compaction response; and to develop a compaction constitutive model that would allow future analysis of reservoir compaction and a surface subsidence. A total of approximately two hundred feet of core was obtained from eleven wells in the two geothermal fields. Depths and porosities ranged from 3500 to 11,000 feet and 15 to 40 percent, respectively. Several samples of geothermal fluids were also obtained. After geologically and geochemically describing the materials obtained, selected specimens were tested for their response to the pressures and temperatures of the geothermal environment and to simulated changes in those conditions that would be caused by production. Short-term tests (for example, tests for compressibility extending over a time interval of an hour or less in the laboratory) indicated that these sedimentary materials behaved normally with respect to the expected behavior of reservoir sandstones of these depths and porosities. Compressibilities were of the order 1×10^{6} psi. Long-term tests, extending up to several weeks in duration, indicated that pore pressure reduction, simulating reservoir production, tended to cause creep compaction at an initial rate of about 1×10^{-7} percent porosity reduction per second.

1508 Geothermal Power Plants

REFER ALSO TO CITATION(S) 29376, 29430, 29432, 29437, 29438

29446 (EPRI-AP—2760, pp 3.21-3.23) **SMUD geothermal development program.** Keilman, L. (Sacramento Municipal Utility District, CA). Dec 1982. NTIS, PC A13/MF A01.

From 6. annual geothermal conference; Snowbird, UT, USA (29 Jun 1982).

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The Sacramento Municipal Utility District (SMUD) is presently building its first geothermal unit in the Geysers called SMUDGEO No. 1, which is 45 percent built. SMUD has, over the past couple of years, bid on lease-holds on both state and Federal land for geothermal mineral rights in the Geysers. SMUD is also pursuing, at the present time, a joint venture with a developer in the Geysers for large acreage. SMUD is participating in the Northern Nevada, NORNEV, Group work effort to develop hot water geothermal. Contracts have been signed with Chevron to develop a first 10 megawatt binary unit at Beowawe, Nevada.

29447 (EPRI-AP—2760, pp 3.24-3.26) **Status of geothermal projects - San Diego Gas and Electric.** Jacobson, W.O. (San Diego Gas and Electric, CA). Dec 1982. NTIS, PC A13/MF A01.

From 6. annual geothermal conference; Snowbird, UT, USA (29 Jun 1982).

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In addition to the Heber Binary Project, San Diego Gas and Electric is actively engaged in a number of projects related to the development of geothermal power. The goal of these projects is to accelerate the technical and economic basis for commercial geothermal power generation in the Imperial Valley to SDG and E's customers. SDG and E is achieving this goal by projects in 3 major areas. The major areas are: (1) geothermal resource exploration and development, (2) geothermal power production facilities, and (3) transmission of geothermal power to San Diego.

29448 (EPRI-AP—2760, pp 3.30-3.34) **Geothermal energy and the state water project.** Struckmeyer, H.; Johnson, B. (California Dept. of Water Resources, Sacramento). Dec 1982. NTIS, PC A13/MF A01.

From 6. annual geothermal conference; Snowbird, UT, USA (29 Jun 1982).

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To deliver over 4 million acre-feet of water to water contractors all over the State of California takes a lot of electrical energy. Much of this water travels over half the length of the State and up a 2800 foot lift over the Tahachapi Mountains. This pumping is the job of the State Water Project (SWP), constructed and operated by the California Department of Water Resources. Furnishing the electrical energy for this task is also the responsibility of

the Department. The Department's geothermal program is discussed as a small, but important, part of the overall effort to maintain an assured supply of electrical energy for the Project.

29449 (EPRI-AP—2760, pp 4.4-4.9) **Overview of EPRI geothermal projects.** Hughes, E.E. (Electric Power Research Inst., Palo Alto, CA). Dec 1982. NTIS, PC A13/MF A01.

From 6. annual geothermal conference; Snowbird, UT, USA (29 Jun 1982).

Portions are illegible in microfiche products.

Major problem areas associated with hydrothermal resource development addressed by the EPRI Geothermal Power Systems Program are discussed as follows: control of scale and corrosion caused by mineral content of hydrothermal brines; preventing adverse effects of the gas content of hydrothermal fluids, especially corrosion, power loes, and pollution; achieving reliable performance despite undesirable properties of the natural hydrothermal fluids; and reaching high efficiencies despite the relatively low temperature of the resource. (MHR)

29450 (EPRI-AP—2760, pp 5.1-5.7) **Heber Binary Project. Binary cycle geothermal demonstration power plant.** Lacy, R.G.; Nelson, T.T. (San Diego Gas and Electric Co., CA). Dec 1982. NTIS, PC A13/MF A01.

From 6. annual geothermal conference; Snowbird, UT, USA (29 Jun 1982).

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The following aspects of the 65 MW (gross) power plant are described: power cycle, design process, turbine-generator, heat exchanger and condenser optimization, materials selection, and cost estimate. (MHR)

29451 (EPRI-AP—2760, pp 5.8-5.14) **Wellhead power production with a rotary separator turbine.** Cerini, D.J.; Record, J. (Biphase Energy Systems, Santa Monica, CA). Dec 1982. NTIS, PC A13/MF A01.

From 6. annual geothermal conference; Snowbird, UT, USA (29 Jun 1982).

Portions are illegible in microfiche products.

A geothermal rotary-separator turbine was designed and operated on a geothermal resource as a wellhead powerplant. It was the first operation of an RST wellhead system producing commercial power from a liquid-dominated resource. Power production above one megawatt was demonstrated. The tests demonstrated reliable operation for 600 hours, with 17 percent power addition to the output of a single stage flash-steam system.

29452 (EPRI-AP—2760, pp 5.15-5.30) **Geothermal steam separator evaluation.** Awerbuch, L.; Van der Mast, V.C.; McGrath, D.P. (Bechtel Group, Inc., San Francisco, CA). Dec 1982. NTIS, PC A13/MF A01.

From 6. annual geothermal conference; Snowbird, UT, USA (29 Jun 1982).

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Bechtel designed and built a field test unit to determine the performance and efficiency of the selected separator types under geothermal operating conditions. Two 50 MW plant design cases were examined to establish design conditions under which steam separators must work. The first case is representative of a high-salinity, high-temperature brine as found near the Niland area of southern California. The second case is representative of moderate-temperature, low-to-intermediate-salinity geothermal fluids, as found in the areas near Heber and East Mesa in southern California. The test unit built includes the following devices: bottom outlet cyclone (BOC), impingement-type vane separator in conjunction with the BOC, and mesh-type separator in conjunction with the BOC. Results of the test program conducted at the East Mesa Test Facility using a low-salinity brine are presented. The test unit operating at East Mesa and a P and ID for the sytem are shown.

29453 (EPRI-AP—2760, pp 6.1-6.12) **Overview of worldwide geothermal power development.** Dipippo, R. (Southeastern Massachusetts Univ., North Dartmouth). Dec 1982. NTIS, PC A13/MF A01.

From 6. annual geothermal conference; Snowbird, UT, USA (29 Jun 1982).

Portions are illegible in microfiche products.

The present status of geothermal installed capacity is tabulated. The recent growth pattern is shown and a breakdown of the current plants is given in terms of plant type. A breakdown according to unit size reveals that the majority of geothermal plants are rated at less than 20 MW. A summary of information on all units believed to have operated, now in operation, under construction, or in the planning stages is provided. This information is given for: The Geysers, other US, Philippines, Italy, New Zealand, Mexico, Japan, El Salvador, Iceland, Kenya, USSR, China, The Azores, Indonesia, and Turkey. (MHR)

29454 (EPRI-AP—2760, pp 6.13-6.17) **Commercial development of the TIWI and MAK-BAN geothermal fields.** Budd, C.F. Jr. (Union Oil Co. of California, San Francisco); Horton, R.M.; Minette, T.N.; Alcaraz, A.P.; Jovellanos, J.U. Dec 1982. NTIS, PC A13/MF A01.

From 6. annual geothermal conference; Snowbird, UT, USA (29 Jun 1982).

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Large scale geothermal energy projects in the Philippines are in full commercial operation. Five 110 MW Geothermoelectric power plants in two separate projects on Luzon came on stream during 1979, 1980 and 1982 bringing the Philippines to the position of second largest producer of geothermal energy in the world, outranked only by the United States. The history of exploration and development of these two commercial geothermal projects is discussed along with some of the operational considerations that have influenced subsequent facility design in an effort to improve both steam processing efficiency and turbine-generator performance.

29455 (EPRI-AP—2760, pp 6.35-6.38) **Small geothermal power plant: portable turbine generator.** Nakamura, N. (Nagasaki Shipyard and Engine Works, Japan). Dec 1982. NTIS, PC A13/MF A01.

From 6. annual geothermal conference; Snowbird, UT, USA (29 Jun 1982).

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Twelve geothermal portable turbine generators manufactured by Mitsubishi are described as to type, output, location, and date operational. (MHR)

29456 (EPRI-AP—2760, pp 6.39-6.52) **Small capacity power plants in geothermal energy exploitation in Italy.** Callai, A. (ENEL S.P.T. G.I.G., Larderello, Italy); Di-Falco, R. Dec 1982. NTIS, PC A13/MF A01.

From 6. annual geothermal conference; Snowbird, UT, USA (29 Jun 1982).

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Two types of geothermal power plants are discussed: the direct back-pressure cycle and the direct condensate cycle. Factors governing the choice of cycle are discussed. The Molinetto and Lagoni Roissi 3 power plants are described. (MHR)

29457 (EPRI-AP—2760, pp 6.53-6.60) **China: 7 MWe geothermal power project at Yangbajing.** DiPippo, R. (Southeastern Massachusetts Univ., North Dartmouth). Dec 1982. NTIS, PC A13/MF A01.

From 6. annual geothermal conference; Snowbird, UT, USA (29 Jun 1982).

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The geothermal field at Yangbajing is the most highly developed one in China, despite its remote and challenging location. It is the highest temperature resource that has been explored and drilled on the mainland, and has been generating electric power since 1977. The geological information available on the site is reviewed; the design of the power plants in operation and under construction are discussed; and certain site-specific design problems are commented on.

29458 (EPRI-AP—2760, pp 6.61-6.68) **Small-scale geothermal electric power units in Iceland.** Gudmundsson, J.S. (Iceland Energy Authority, Reykjavik). Dec 1982. NTIS, PC A13/MF A01.

From 6. annual geothermal conference; Snowbird, UT, USA (29 Jun 1982).

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There are five small-scale geothermal electric power units in Iceland: one 3 MW/sub e/, two 1 MW/sub e/, one 6 MW/sub e/ and one 338 kW/sub e/. The first was installed in 1969 in Namafjall to gain experience in operating a geothermal electric power plant. The two 1 MW/sub e/ and 6 MW/sub e/ units are all in the (mainly) thermal power plant in Svartsengi, installed in 1978, 1979 and 1980. The smallest unit was installed in 1980 in Nesjavellir. There are several plans to install small-scale units to be operated in conjunction with thermal or direct uses of geothermal steam.

29459 (EPRI-AP—2760, pp 7.1-7.6) **Geothermal power system modules available for power on line in 1984.** Nichols, K.E. (Barber-Nichols Engineering Co., Arvada, CO). Dec 1982. NTIS, PC A13/MF A01.

From 6. annual geothermal conference; Snowbird, UT, USA (29 Jun 1982).

Portions are illegible in microfiche products.

The feasibility of geothermal power modules that can be factory built and field assembled to form wellhead power plants is explored. The direct contact binary plant and the Matthews gravity-head plant are described. (MHR)

29460 (EPRI-AP—2760, pp 7.7-7.16) **Generating capability of the Baca geothermal field.** Bodvarsson, G.S.; Tsang, C.F. (Lawrence Berkeley Lab., CA). Dec 1982. NTIS, PC A13/MF A01.

From 6. annual geothermal conference; Snowbird, UT, USA (29 Jun 1982).

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A 50 MW geothermal power plant is being considered at the Baca site in the Valles Caldera, New Mexico, as a joint venture of the Department of Energy (DOE), Union Oil Company of California and the Public Service Company of New Mexico (PNM). To date, over 20 wells have been drilled on the prospect, and the data from these wells indicate the presence of a high-temperature liquid-dominated reservoir. In this paper, data from open literature on the field are used to estimate the amount of hot water in place (reservoir capacity) and the length of time the reservoir can supply steam for a 50 MW power plant (reservoir longevity). The reservoir capacity is estimated by volumetric calculations using existing geological, geophysical and well data. The criteria used are described and the sensitivity of the results discussed. The longevity of the field is studied using a two-phase numerical simulator (SHAFT79). A number of cases are simulated based upon different boundary conditions, and injection/ production criteria. The results obtained from the simulation studies indicate that it is questionable that the Baca field can supply enough steam for a 50 MW/sub e/ power plant for 25 to 50 years. Although the estimated reservoir reserves greatly exceed those needed for a 50 MW/sub e/ power plant, the low transmissivity of the reservoir causes very localized boiling, and subsequently a very rapid pressure decline. It is therefore apparent that the conventional zero-dimensional (lumped-parameter) models cannot be used to evaluate the generating capacities of low permeability fields such as the Baca field.

29461 (EPRI-AP—2760, pp 8.6-8.9) **Resolving technical engineering issues.** Finney, J. (Gibbs and Hill, Inc., San Jose, CA). Dec 1982. NTIS, PC A13/MF A01.

From 6. annual geothermal conference; Snowbird, UT, USA (29 Jun 1982).

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The design of geothermal power plants requires the resolution of a set of technical issues which is unique to the industry. These issues are discussed, as follows: resource assessment and contracting, environmental issues, economic optimization, design optimization, standardized modular plant equipment, and qualified engineering management team. (MHR)

29462 **Velocity pump reaction turbine.** House, P.A. (to Dept. of Energy). US Patent 4,332,520. 1 Jun 1982. Filed date 29 Nov 1979. vp.

PAT-APPL-098450.

An expanding hydraulic/two-phase velocity pump reaction turbine including a dual concentric rotor configuration with an interrotor annular flow channel in which the inner rotor is mechanically driven by the outer rotor. In another embodiment, the inner rotor is immobilized and provided with gas recovery ports on its outer surface by means of which gas in solution may be recovered. This velocity pump reaction turbine configuration is capable of potential energy conversion efficiencies of up to 70%, and is particularly suited for geothermal application

1509 Geothermal Engineering

REFER ALSO TO CITATION(S) 29449

29463 **(BRGM-DOC—33) Thermal behaviour of aquifer reservoirs for hot water storage or for low enthalpy geothermics.** Sauty, J.P. (Bureau de Recherches Geologiques et Minieres (BRGM), 45 - Orleans (France); Grenoble-1 Univ., 38 (France)). 1982. 293p. (In French). NTIS (US Sales Only), PC A13/MF A01. Order Number DE83750443.

Portions are illegible in microfiche products; Thesis.

The purpose of this work is to provide the requisite elements for conceiving concrete methods for dimensioning the structures, predict the performances and define an optimal operational strategy. The underground heat transfers are analyzed right from the basic equations on a level with the elementary particle up to the characteristic equations on a scale of the elementary volume representative of the equivalent continuous environment. The phenomena considered macroscopically on the scale of the reservoir and its walls are characterized by integrating the representative elementary volume equations. The stress is particularly placed on the tilting of the thermal fronts and on the thermal macrodispersion resulting from the heterogeneity of the field of permeabilities. The relative order of magnitude of the various transfer modes is examined. A system of simplified but representative equations is derived. A formalization, according to reduced variables, is sought, to enable the operation of an installation to be characterized by a minimal number of parameters. The working of a storage by single well is studied: descriptions of experiments carried out on site and their interpretation, building of universal nomograms for predicting the thermal change of the water on coming from the storage. Similar results are presented for reinjection operation; general theoretical study of the geothermal doubles, effects on the storages of hot and/ or cold water in dual, comparison of the theoretical results and the observations carried out during on-site experiments

29464 **(DOE/SF/11503—1) Corrosion reference for geothermal downhole materials selection.** Ellis, P.F. II, Smith, C.C.; Keeney, R.C.; Kirk, D.K.; Conover, M.F. (Radian Corp., Austin, TX (USA)). Mar 1983. Contract AC03-81SF11503. 332p. NTIS, PC A15/MF A01. Order Number DE83010306.

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Geothermal downhole conditions that may affect the performance and reliability of selected materials and components used in the drilling, completion, logging, and production of geothermal wells are reviewed. The results of specific research and development efforts aimed at improvement of materials and components for downhole contact with the hostile physicochemical conditions of the geothermal reservoir are discussed. Materials and components covered are tubular goods, stainless steels and non-ferrous metals for high-temperature downhole service, cements for high-temperature geothermal wells, high-temperature elastomers, drilling and completion tools, logging tools, and downhole pumps. (MHR)

29465 (EPRI-AP—2760, pp 3.15-3.17) **Utility geothermal plans: Texas and Louisiana.** Ridgway, J.R. Jr. (Houston Lighting and Power Co., TX). Dec 1982. NTIS, PC A13/MF A01.

From 6. annual geothermal conference; Snowbird, UT, USA (29 Jun 1982).

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The present status of four design wells, one in Texas and three in Louisiana, is reported. The wells are: Pleasant Bayou No. 2, Gladys McCall, Sweet Lake, and Parc Perdue. (MHR)

29466 (EPRI-AP—2760, pp 4.10-4.12) **EPRI geothermal projects overview: chemistry projects.** Kruger, P. (Electric Power Research Inst., Palo Alto, CA). Dec 1982. NTIS, PC A13/MF A01.

From 6. annual geothermal conference; Snowbird, UT, USA (29 Jun 1982).

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The results are summarized for the following EPRI projects: scale simulation computer codes, mobile chemistry laboratory, and scale control by crystallization. (MHR)

29467 (EPRI-AP—2760, pp 5.31-5.44) **Geothermal scale control by crystallization.** Awerbuch, L.; Van der Mast, V.C.; Rogers, A.N. (Bechtel Group, Inc., San Francisco, CA). Dec 1982. NTIS, PC A13/MF A01.

From 6. annual geothermal conference; Snowbird, UT, USA (29 Jun 1982).

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Simple, straightforward process and equipment for the control of all types of scale were developed. The process is based on the well known slurry seeding technique, which has been in successful commercial use in the food and chemical industries for many years. The seeding and slurry settling steps are conducted in two flasher-crystallizer-separators (FCS) of novel design, described here which effect the prompt contacting of brine with a large number of seed crystals at the instant of flashing. The two stage design segregates the high temperature scale rich in heavy metals from the chemically different, low temperature scale. The overflow brine, still somewhat supersaturated, is completely stabilized by reheat and dilution by means of a small fraction of the flashed steam and of the turbine condenser condensate.

29468 (SAND—82-0863) **Euler buckling of geothermal well casing.** Rechard, R.P.; Schuler, K.W. (Sandia National Labs., Albuquerque, NM (USA)). Feb 1983. Contract AC04-76DP00789. 65p. NTIS, PC A04/MF A01. Order Number DE83010292.

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Geothermal well operators have expressed concern over the vulnerability of unsupported casing to buckling from thermal elongation. Preliminary numerical and theoretical calculations are presented, which indicate the buckling phenomenon should not be serious in N-80 casing if the string is tension preloaded. Buckling would be detrimental for K-55 casing. The effect of wall contact was found to be beneficial for closely confined pipe strings and of no detriment when hole gaps are large. The weakness of API screw joints in bending appears to be the structural limitation. The analysis assumed stresses above yield constituted failure, that thermal expansion was strain controlled, and that the casing was continuous. Excessive internal pressure instability was ignored. The temperature variation considered was between cementing conditions of 100 to 200°F (40 to 95°C) and shut-in conditions of 425 to 450°F (220 to 230°C).

1510 Direct Energy Utilization

REFER ALSO TO CITATION(S) 29429, 29432

29469 (EUR—8241-EN) **Technical and economic feasibility of low-enthalpy geothermal projects in the E.E.C. Final report.** (Commission of the European Communities, Brussels (Belgium). Directorate General for Science, Research and Development). 1982. 291p. European Community Information Service, 2100 M Street N.W., Suite 707, Washington, DC 20037.

The technical and economic feasibility of exploiting resources between 30°C and 150°C is explored. The following are discussed: uses of low enthalpy geothermal energy, existing operations and projects in Europe, and the organizational context for European low-energy geothermal resources. (MHR)

1520 Geothermal Data And Theory

REFER ALSO TO CITATION(S) 29445, 30022

29470 (EPRI-AP—2760, pp 5.45-5.53) **Mobile laboratory: chemical analysis at geothermal sites.** Jamin, M.E. (Rockwell International, Newbury Park, CA). Dec 1982. NTIS, PC A13/MF A01.

From 6. annual geothermal conference; Snowbird, UT, USA (29 Jun 1982).

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The EPRI Mobile Geothermal Laboratory, CHEMLAB, was designed to address a broad spectrum of chemical and physical questions concerning geothermal systems, from initial resource survey through power plant operation. CHEMLAB activities, EPRI geothermal chemistry data base, sampling and analysis procedures and stategic uses of the EPRI mobile geothermal laboratory are described.

29471 (LA-tr—83-6) **WATCH1 and the WATCH3 programs: vehicles for interpreting chemical analyses of geothermal water. A guide for users.** Svavarsson, H. (Los Alamos National Lab., NM (USA)). 1983. Contract W-7405-ENG-36. Translated from Forritin WATCH1 og WATCH3: hjalpartaeki til tulkunar efnagreininga a jardhitavatni. Leidbeininggar fyrir notendur. Orkustofnun (Iceland National Energy Authority), Geothermal Division, Reykjavik, 1981. 15p. NTIS, PC A02/MF A01. Order Number DE83010885.

The WATCH1 and WATCH3 are computer programs written according to the Fortran IV language for the PDP-11/34 computer of the Icelandic National Energy Authority. The programs compute the chemical composition of hot geothermal water and steam, their activity coefficients, major chemical components (types of these), chemical temperature, degassing rate and oxidation level as well as some mineral balances on the basis of a given chemical analysis of geothermal water at the surface. The programs are also able to produce calculations for chemical analyses of cold water. The WATCH1 can be used for chemical analyses of water and steam from steam producing boreholes. The WATCH3 is exclusively used for chemical analyses of water from boiling springs, springs and boreholes where the water has not reached boiling stage or for cold water.

16 TIDAL POWER

1605 Environmental Aspects

29472 (AD-A—123262/8) **Investigation of tidal power, Cobscook Bay, Maine. Environmental Appendix.** (Corps of Engineers, Waltham, MA (USA). New England Div.). Aug 1980. 194p. NTIS, PC A09/MF A01.

This report presents information regarding existing terrestrial and marine resources and water quality conditions in the Cobscook Bay area. A preliminary assessment of impacts from a tidal power project is also presented and data gaps are identified. Reports contained in the appendix were prepared by the U.S. Fish and Wildlife Service, the National Marine Fisheries Service, the University of Maine at Orino, School of Forestry Resources and the U.S. Army Corps of Engineers.

1607 Tidal Power Plants

29473 **Pressure balanced drag turbine mass flow meter.** Cole, J.H.; Dacus, M.W. (to Dept. of Energy). US Patent 4,333,355. 8 Jun 1982. Filed date 23 Apr 1980. vp.

PAT-APPL-143058.

The density of the fluid flowing through a tubular member may be measured by a device comprising a rotor assembly suspended within the tubular member, a fluid bearing medium for the rotor assembly shaft, independent fluid flow lines to each bearing chamber, and a scheme for detection of any difference between the upstream and downstream bearing fluid pressures. The rotor assembly reacts to fluid flow both by rotation and axial displacement; there-

fore concurrent measurements may be made of the velocity of blade rotation and also bearing pressure changes, where the pressure changes may be equated to the fluid momentum flux imparted to the rotor blades. From these parameters the flow velocity and density of the fluid may be deduced.

1608 Wave Energy Converters

29474 (CONF-810622—Vol.1, pp 183-188) **Performance evaluation of generic wave energy systems.** Picha, K. (Gibbs & Cox, Inc., Arlington, VA); Midboe, E.; Hudon, T.; McCormick, M. Jun 1981. NTIS, PC A24.

From 8. ocean energy conference; Washington, DC, USA (7 Jun 1981).

An evaluation of generic type wave energy systems has been conducted as part of an ongoing study, with the goal of developing a comprehensive methodology to evaluate wave energy systems from an engineering and economic perspective. This paper describes the results of the performance evaluation in which generic wave energy systems have been assessed for their wave energy extraction and electrical power conversion potential. These results are expected to be utilized as input to a synthesis task. The task will incorporate the extraction and conversion systems in an integrated ocean wave energy conversion system to permit development of cost per unit power figures for each of the generic devices.

29475 (CONF-810622—Vol.1, pp 199-204) **DAM-ATOLL development progress.** Sherburne, C.P. (Lockheed Missiles & Space Co., Inc., Sunnyvale, CA); Davidoff, P.H. Jun 1981. NTIS, PC A24.

From 8. ocean energy conference; Washington, DC, USA (7 Jun 1981).

The DAM-ATOLLl studies now in progress constitute the first detailed investigations of the system, and are directed to providing a design data base for small-scale model design and tests in the next phase of the program, and for subsequent design effort for large and full-scale systems. Results obtrained thus far in the program have shown technical feasibility of the concept, and encourage continued effort toward development of the system. Preliminary determination of capital costs, and predicted cost-of-production of electricity indicate promise of economic feasibility with further development.

29476 (CONF-810622—Vol.1, pp 205-210) **Focusing of ocean wave energy and future challenges.** Stettner, R. (Mission Research Corp., Santa Barbara, CA). Jun 1981. NTIS, PC A24.

From 8. ocean energy conference; Washington, DC, USA (7 Jun 1981).

Physical effects are investigated that may influence the efficiency of wave focusing devices. These effects are wave breaking, interference, phasing, wave front direction and defocusing. Reference is made to an ellipsoidal lens system to illustrate the effects.

29477 (CONF-810622—Vol.1, pp 211-215) **Chracteristics of waves in the Japan Sea.** Midorikawa, K.; Takahashi, K. Jun 1981. NTIS, PC A24.

From 8. ocean energy conference; Washington, DC, USA (7 Jun 1981).

In utilizing wave energy, the variations of both wave height and energy must be taken into consideration. Short-period variations in wave height had a humming period which varied from a minimum of 30 seconds to a maximum of 3 minutes. These periodic variations were considered to be beat phenomena which were analyzed by spectrum.

17 WIND ENERGY

1701 Availability (climatology)

29478 (PNL-SA—10852) **Wind-shear climatology for large wind-turbine generators.** Elliott, D.L.; Wendell, L.L.; Heflick, S.K. (Pacific Northwest Lab., Richland, WA (USA)). Sep 1982. Contract AC06-76RL01830. 15p. (CONF-830441—1). NTIS, PC A02/MF A01. Order Number DE83010347.

From 6. international conference of wind engineering; Auckland, New Zealand (6 Apr 1983).

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The major objective of this report is to provide climatological wind shear analyses relevant to the design and operation of multimegawatt wind turbines. A simple analysis of different shear profiles under steady flow conditions is presented to provide insight for relating the wind forcing experienced by a rotating blade to the results of the statistical analysis of wind shear conditions. This analysis scheme was developed to establish a climatology of wind shear profiles derived from 10-s sampled winds and hourly average winds measured over a one-year period at several levels on a tall tower. Because of the sensitivity of the forcing function variability to profile shape, the analyses performed and presented are in the form of joint frequency distributions of velocity differences of the top-to-hub versus the hub-to-bottom portion of disks of rotation for three turbine configurations. The joint frequency distributions of 10-s sampled winds indicated that a rotating blade would experience a much wider range of shear conditions and a higher percentage of extreme shears than indicated by hourly averaged data. The joint frequency distributions of wind shear profiles are significantly different for the three wind turbine configurations.

29479 (UHMET—82-05) **Wind-energy assessment for the western Pacific based on ship reports.** Schroeder, T.A.; Hori, A.M. (Hawaii Univ., Honolulu (USA). Dept. of Meteorology). Nov 1982. Contract AT03-82SF11642. 28p. NTIS, PC A03/MF A01. Order Number DE83008149.

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Over 468,000 wind reports from ships traversing the Pacific Islands (Micronesia) affiliated with the United States have been examined. From these data, maps were prepared of annual and seasonal average wind speed and wind energy density and wind rose summaries for 100 2° by 5° (latitude by longitude) boxes. The Northern Marshall Islands possess the best wind energy resource in the region, the Northern Marianas the next best. Tropical storms exert a limited influence on the wind statistics. Future research should first concentrate on evaluating wind characteristics on one atoll, and then on one high island.

1706 Wind Energy Engineering

29480 (DOE/NASA/0182—1) **Fatigue testing of low-cost fiberglass composite wind turbine blade materials.** Hofer, K.E.; Bennett, L.C. (IIT Research Inst., Chicago, IL (USA)). Nov 1981. Contract AI01-76ET20320. 87p. (NASA/CR—165566). NTIS, PC A05/MF A01. Order Number DE83009045.

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The static and fatigue behavior of transverse filament tape (TFT) fiberglass/epoxy and TFT/polyester composite was established by the testing of specimens cut from panels fabricated by a filament winding process used for the construction of large experimental wind turbine blades. Static mechanical properties obtained included tension, compression, and interlaminar shear at ambient conditions in high-humidity/high-temperature conditions after a 500-hour exposure to such an environment. The fatigue data were obtained at similar environmental exposures and at several R ratios including R = 0, 0.1, -0.25, -0.5, and -1. Negative ratios imply a compressive component of stress. Testing was performed to failure in many cases. S-N diagrams and a modified Goodman constant life plot were obtained for one of two types of the epoxy matrix composites. The elastic properties of the epoxy matrix materials showed a strong dependence only on the filament stiffness and angle and a weak influence of the high-humidity/high-temperature environment. The polyester materials showed a substantial decrease in compressive strength for some composites which had been exposed

for over 4000 hours in the high-humidity/high-temperature environment.

29481 **(DOE/NASA/3303—4) Development of methodology for horizontal-axis wind-turbine dynamic analysis. Summary report.** Dugundji, J. (Massachusetts Inst. of Tech., Cambridge (USA). Aeroelastic and Structures Research Lab.). Sep 1982. Contract AI01-76ET20320. 9p. (NASA/CR—168110). NTIS, PC A02/MF A01. Order Number DE83011212.

The 3-year effort reported included: (1) review of the MOSTAS computer programs for dynamic analysis of horizontal-axis wind turbines; (2) review of various analysis methods for rotating systems with periodic coefficients; (3) review of structural dynamics analysis tools for large wind turbine; (4) experiments for yaw characteristics of a rotating rotar; (5) development of a finite element model for rotors; (6) development of simple models for aeroelastic; and (7) development of simple models for stability and response of wind turbines on flexible towers.

29482 **(EPRI-AP—2906) Application examples for wind-turbine siting guidelines. Final report.** Wegley, H.L.; Pennell, W.T. (Battelle Pacific Northwest Labs., Richland, WA (USA)). Mar 1983. Contract AC06-76RL01830. 119p. NTIS, PC A06/MF A01. Order Number DE83011036.

The trial application by two utilities of wind-turbine cluster siting guidelines are described. The trial application was intended to provide realistic examples of the use of the siting guidelines. The activities of the two utilities are discussed, labor/time estimates are given for each stage of the siting guidelines, and baseline economic (as well as other) assumptions are provided for both utilities. In addition, the sensitivity of wind turbine economics to two types of wind turbine performance models is examined. Results of the trial application indicate that procedures used for siting conventional energy facilities can be successfully adapted to the siting of wind turbines. The major uncertainties in the trial application include estimates of hardware lifetime, capital cost of the hardware, operations and maintenance costs, and operational impacts of wind turbines on the utility system.

29483 **(PB—83-147413) Aerodynamic research on tipvane wind turbines.** van Bussel, G.J.W.; van Holten, Th.; van Kuik, G.A.M. (Technische Hogeschool Delft (Netherlands). Dept. of Aerospace Engineering). Apr 1982. 19p. NTIS, PC A02/MF A01.

The research on tipvane turbines aims at a process improvement of the wind energy conversion system, which is more than component improvement such as efficient aerofoils and optimized transmission systems. These latter developments make it possible for a modern wind turbine to approach the Betz maximum power coefficient. However, process improvements are possible based on flow phenomena which are not consistent with the assumptions made in Betz theory. Power coefficients far above the Betz maximum value are possible when for example forces are applied perpendicular to the wind direction and when viscous effects play an important role. At the Delft University of Technology, the wind energy group investigates the effect of tipvanes, which are small auxiliary wings at the end of the turbine blades inducing a mass flow augmentation by the creation of a venturi flow.

29484 **(PNL—4572) Wake structure measurements at the Mod-2 cluster test facility at Goodnoe Hills.** Lissaman, P.B.S.; Zambrano, T.G.; Gyatt, G.W. (AeroVironment, Inc., Pasadena, CA (USA)). Mar 1983. Contract AC06-76RL01830. 49p. NTIS, PC A03/MF A01. Order Number DE83010626.

A field measurement progam was carried out at the cluster of three MOD-2 wind turbines located at Goodnoe Hills, Washington, to determine the rate of decay of wake velocity deficit with downwind distance in various meteorological conditions. Measurements were taken at hub height (200 ft) between July 12 and August 1, 1982. Wake wind speeds were measured using a radiosonde suspended from a tethered balloon, its position being determined from a grid of ground stakes. Measurments were also made downwind with the turbine off to determine the magnitude of terrain-induced variations in wind speed. The balloon system used to measure downstream wind data proved to be reliable and convenient. Downstream distances of 900, 1500, 2100, and 2700 ft from the turbine were investigated. Differences between the instrumentation systems required that corrections be made to the data. After correction, averaged terrain-induced wind speed variations were regarded as insignificant. Turbine-on velocity ratios showed scatter, suggesting that only some measurements were, in fact, representative of wake centerline velocities, and that others were made off centerline due to wake meander or wind shift. Isolation of the high wind speed (30 to 45 mph) velocity ratios, however, revealed velocity deficits downstream. Measurements at greater downstream distances showed no wake deficit within the limits of resolution of the experiment, indicating that the wake had recovered to free stream conditions. Comparison with the AeroVironment wake model using common values for rotor drag coefficient and turbulence showed similar trends.

29485 **(SAND—82-2341C) Rotationally-sampled flow-field measurements for vertical-axis wind turbines.** Akins, R.E. (Sandia National Labs., Albuquerque, NM (USA)). 1983. Contract AC04-76DP00789. 6p. (CONF-830432—2). NTIS, PC A02/MF A01. Order Number DE83009550.

From Wind/solar energy conference; Kansas City, MO, USA (25 Apr 1983).

This effects a wind-turbine blade moving through a turbulent flow field have on the feequency content of the relative velocity seen by the blade are an important aspect of the aerodynamically induced loads and may also contribute to the fatigue loads. Recent work has emphasized these effects in large horizontal-axis turbines. Measurements of a rotationally-sampled flow field using the DOE/Sandia 17-m research turbine have been completed. These measurements show increased energy content at integer multiples of rotation rate and indicate why rotational sampling may be an important concept in rotor design. These measurements are the first to have been conducted on an operational turbine in a field environment.

29486 **(SAND—82-2366C) Recent improvements to the VDART3 VAWT code.** Berg, D.E. (Sandia National Labs., Albuquerque, NM (USA)). 1983. Contract AC04-76DP00789. 11p. (CONF-830432—1). NTIS, PC A02/MF A01. Order Number DE83009935.

From Wind/solar energy conference; Kansas City, MO, USA (25 Apr 1983).

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VDART3, the three-dimensional vortex-filament based computer model of the curved-blade type Vertical Axis Wind Turbine (VAWT), models the turbine aerodynamic phenomena in far more detail than virtually any other VAWT code in use today. Consequently, it yields far more accurate calculations of turbine blade loading, turbine torque production and turbine near wake structure than the other VAWT codes. Recent work on the code includes the addition of a dynamic stall model, consideration of dynamic pitching and blade mounting location effects, and the development of several techniques for reducing execution time without sacrificing code accuracy. This work has resulted in far better agreement of code results with experimental data at low tip-speed ratios and in execution times that have been reduced by an order of magnitude with virtually no loss in code accuracy.

29487 **(SAND—82-7113/1) Design and fabrication of a low cost Darrieus vertical axis wind turbine system: Phase II. Volume 1. Executive summary.** (Aluminum Co. of America, Alcoa Center, PA. Alcoa Labs.). Mar 1983. Contract AC04-76DP00789. 51p. NTIS, PC A04/MF A01. Order Number DE83010218.

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Described is the successful fabrication, installation, and checkout of 100 kW 17 metre Vertical Axis Wind Turbines (VAWTs). The turbines are Darrieus-type VAWTs with rotors 17 metres (55 feet) in diameter and 25.15 metres (83 feet) in height. They can produce 100 kW of electric power at a cost of energy as low as 3 cents per kWh, in an 18 mph wind regime using 12% annualized costs. Four turbines were produced; three are installed and are operable at: (1) Wind Systems Test Center, Rocky Flats, Colo-

rado; (2) the US Department of Agriculture Conservation and Production Research Center at Bushland, Texas; and (3) Tisbury Water Authority, Vineyard Haven, Massachusetts, on the island of Martha's Vineyard. The fourth turbine is stored at Bushland, Texas, awaiting selection of an erection site.

29488 **(SAND—82-7113/3) Design and fabrication of a low-cost Darrieus vertical-axis wind-turbine system, Phase II. Volume 3. Design, fabrication, and site drawing.** (Aluminum Co. of America, Alcoa Center, PA. Alcoa Labs.). Mar 1983. Contract AC04-76DP00789. 121p. NTIS, PC A06/MF A01. Order Number DE83010900.

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This report contains the design, fabrication, and site drawings associated with fabrication, installation, and check-out of 100-kW 17-metre Vertical-Axis Wind Turbines (VAWTs), under a 2-year, $1.8 million Phase II contract with the US Department of Energy. Design by Alcoa in Phase I of this contract, the turbines are Darrieus-type VAWTs with rotors 17 metres (55 feet) in diameter and 25.15 metres (83 feet) in height. They can produce 100 kW of electric power at a cost of energy as low as 3 cents per kWh, in an 18-mph wind regime using 12% annualized costs. Four turbines were produced; three are installed and are operable at (1) the Wind Systems Test Center, Rocky Flats, Colorado; (2) the US Department of Agriculture Conservation and Production Research Center at Bushland, Texas; and (3) Tisbury Water Authority, Vineyard Haven, Massachusetts, on the island of Martha's Vineyard. The fourth turbine is stored at Bushland, Texas, awaiting selection of an erection site.

29489 **Analysis and simulation of storm induced WECS generation changes on system operation.** Schlueter, R.A.; Park, G.L.; Modir, H.; Doresey, J.; Lotfalian, M. (Mich State Univ, East Lansing, USA). pp 9p, Paper 82WM 250-9 of IEEE Power Engineering Society winter meeting. New York, NY; IEEE (1982).

From IEEE Power Engineering Society winter meeting; New York, NY, USA (30 Jan 1982).

The effects of simultaneous load and Wind Electric Conversion System (WECS) generation changes on automatic generation control, frequency regulation, and economic dispatch are determined via simulation. It is shown that the total of load and WECS generation change in a ten minute interval must be less than load following capability for that period or a severe saturation problem occurs. A cycling problem is shown to occur if storm induced WECS generation change will cause frequency deviations that exceed governor deadband. Both problems can be solved if partial shutdown of generation is undertaken in each echelon to reduce frequency deviations below governor deadband and in the farm to reduce total required generation change below load following capability. 7 refs.

29490 **Modification of power system operation for significant wind generation penetration.** Schlueter, R.A.; Park, G.L.; Lotfalian, M.; Shayanfar, H.; Dorsey, J. (Mich State Univ, East Lansing, USA). pp 10p, Paper 82WM 249-1 of IEEE Power Engineering Society winter meeting. New York, NY; IEEE (1982).

From IEEE Power Engineering Society winter meeting; New York, NY, USA (30 Jan 1982).

Modification of unit commitment, economic dispatch, regulation and frequency regulation controls when the level of wind generation capacity is significant is discussed. A wind farm penetration constraint is determined, that limits worst case wind generation change from an array due to a thunderstorm to be les than the worst first contingency loss of conventional generation resource or commitment. The farm penetration constraint only acts as an indicator that additional spinning reserve, load following, and unloadable generation capability is required through adjustment of unit commitment and AGC controls if the farm penetration constraint) is then discussed. A further discussion of the modification of regulation and economic dispatch controls to exploit the changes in response rate capability provided by the unit commitment is also discussed. A modified echelon penetration constraint is proposed that limits instantaneous rate of change and change from a wind array that muss constraint is imposed to limit cycling of units which can incur additional operating and maintainance costs on conventional steam units and possibly safety concerns on nuclear units. 7 refs.

29491 **Assessment of load frequency impacts caused by small wind turbines.** Curtice, D.H.; Reddoch, T.W. (Syst Control Inc, Palo Alto, CA, USA). pp 9p, Paper 82WM 252-5 of IEEE Power Engineering Society winter meeting. New York, NY; IEEE (1982).

From IEEE Power Engineering Society winter meeting; New York, NY, USA (30 Jan 1982).

A method is presented to analyze the effects small wind turbines' (WTs) output may have on the load frequency control process. A simulation model of a utility's automatic generation control (AGC) process is used with recorded real-time system load data modified by synthesized data characterizing the aggregate output of small WTs. A series of WT scenarios are defined for various WT penetrations of the total system load. WT output scenarios, varying in frequency and magnitude, are combined with system load variations to test the effectiveness of present AGC control strategies. System peformance change from the base case is assessed using area control error (AGC) values, time between zero crossings, inadvertent accumulation, and control pulses sent to regulating units. 7 refs.

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REFER ALSO TO CITATION(S) 28809, 28810, 28820, 28966, 28992, 29526, 29771, 29780, 29826, 29843

29492 **(CONF-830343—1) Coal-fired power-plant cost estimates.** Fox, E.C. (Oak Ridge National Lab., TN (USA)). 18 Mar 1983. Contract W-7405-ENG-26. 89p. NTIS, PC A05/MF A01. Order Number DE83009861.

From Coal development and utilization workshop on coal fired power plant cost estimating; Argonne, IL, USA (18 Mar 1983).

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The slides used to illustrate a talk on the principles of coal plant economics are compiled. The subjects discussed include capital cost estimates, the CONCEPT computer code for estimating capital investment cost for nuclear and coal-fired power plants; operating cost estimates; fuel cost estimates; and the costing of fluidized-bed combustion. (LCL)

29493 **(CW-WR—76-020.109) High temperature turbine technology program. Phase II. Technology test and support studies. Technical progress report, April 1, 1982-June 30, 1982.** (Curtiss-Wright Corp., Wood-Ridge, NJ (USA)). Feb 1983. 32p. NTIS, PC A03/MF A01. Order Number DE83008413.

The status of work performed on the High Temperature Turbine Technology Program, Phase II Technology Test and Support Studies during the Second Quarter of 1982, April 1 through June 30, 1982 is presented. Work was initiated on the turbine vane aerodynamic cascade test program. The objective of this effort is to evaluate the level of aerodynamic losses associated with a transpiration air-cooled airfoil and with a solid, uncooled airfoil of identical profile. During this period, an initial test plan and analytical techniques were formulated. The test plan includes testing both solid and TAC vanes at various pressure ratios, cooling air flows and cooling air temperature to primary flow ratios. Rework of the 60° cascade test rig to incorporate a modified combustor section upstream of the cascade vanes was completed. Pressure measurement instrumentation was installed on the solid and TAC vanes. Facility modifications as well as rework of existing equipment to fit the cascade test rig were both completed. Computer data acquisition and analysis calculation procedure programming were completed and checked out on the test stand. Work was initiated to develop a method by which the skin permeability of a TAC airfoil would be reduced to zero without altering the characteristic roughness of the skin. Extended time oxidation testing of Nichrome V-Cb material porous mesh for transpiration air-cooled turbine airfoils is continu-

ing; test to date has reached over 7000 hours exposure time toward a planned 10,000 h total.

29494 **(CW-WR—76-020.110) High Temperature Turbine Technology Program. Phase II. Technology test and support studies. Technical progress report, July 1, 1982-September 30, 1982.** (Curtiss-Wright Corp., Wood-Ridge, NJ (USA)). Feb 1983. 44p. (FE—2291-110). NTIS, PC A03/MF A01. Order Number DE83008412.

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The status of work performed on the High Temperature Turbine Technology Program, Phase II Technology Test and Support Studies during the Third Quarter of 1982, July 1 through September 30, 1982 is presented. The objective of this effort is to evaluate the level of aerodynamic losses associated with a transpiration air-cooled (TAC) airfoil and with a solid uncooled air foil of identical profile. The test plan inlcudes the test program for both solid and TAC vanes at various parameters as well as definition of the exact calculation procedure for analysis of data. Performance tests were conducted with the uncooled solid vane cascade rig at various pressure ratios and base pressure levels of 4 atms. Operational problems with over-heating of the sweep probe actuator motors were resolved by increased insulation and air cooling of the probe housing from the 1000°F primary air flow. Analysis of the data and instrument calibration as well as repeatability confirmed the reliability of the test results. As a result, the cascade solid vane configuration was converted to TAC vanes for the next test phase. Aerodynamic performance testing with the TAC vane cascade configuration was conducted at various pressure ratios (primary and cooling), cooling flows and primary/coolant temperature ratios. A check of instrumentation, repeatability and calibration comparisons confirmed the reliability of the test data and thereby concluding this test phase of the program. The analysis concluded that efficiency, loss coefficient and flow capacity test results were in good agreement with predicted values for both the TAC and uncooled vanes. The testing demonstrated that it is necessary to conduct test evaluations of transpiration air-cooled components at or near design coolant to gas stream temperature ratio to achieve correct results.

29495 **(CW-WR—76-020.115) High Temperature Turbine Technology Program. Phase II. Technology test and support studies. Technical progress report, October 1, 1982-December 31, 1982.** (Curtiss-Wright Corp., Wood-Ridge, NJ (USA). Power Systems Div.). Feb 1983. Contract AC01-76ET10348. 14p. (FE—2291-115). NTIS, PC A02/MF A01. Order Number DE83008933.

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This report presents the status of work performed on the High Temperature Turbine Technology Program, Phase II Technology Test and Support Studies during the fourth quarter of 1982, October 1 through December 31, 1982. The objective of this effort is to evaluate the level of aerodynamic losses associated with a transpiration air-cooled airfoil and with a solid uncooled airfoil of identical profile. All work was completed in this period. This report discusses the calibration of the traversing probe, the completion of the Topical Report and the completion of the extended oxidation testing on mesh alloys.

29496 **(DOE/EIA—0075(82/12)) Cost and quality of fuels for electric utility plants.** (USDOE Energy Information Administration, Washington, DC. Office of Coal, Nuclear, Electric and Alternate Fuels). Dec 1982. 68p. NTIS, PC A04/MF A01. Order Number DE83010374.

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Electric generating plants with a total combined capacity of 25 megawatts of greater received fossil fuels equivalent to 1.37 quadrillon British thermal units (Btu) in December 1982, of which 99.5 percent was for steam-electric generation. Measured by their total heat content, fossil-fuel receipts for steam-electric generation decreased 2.7% from November, and were 10.6% lower than December 1981. A historical comparison of the heat content of fossil fuels expressed in Btu for steam-electric units, and the combination of peaking units and steam-electric units are listed. The total coal receipts at steam-electric units during the month of December decreased to 49.7 million short tons, 3.6 million short tons lower than shipments received during the month of December 1981. Oil receipts for steam-electric generation were 17.8 million barrels during December, 8.8 million barrels lower than shipments received in December of last year. Gas receipts at steam-electric units totaled 201.9 billion cubic feet (Bcf), 22.0 Bcf lower than last Deember's level. During December, the cost of coal at steam-electric units averaged 162.8 cents per million Btu, 3.9% higher than the average cost a year ago. The average cost of all oil received at steam units was 461.5 cents per million Btu, 9.5 percent lower than the average cost of oil in December 1981. Steam-electric gas costs averaged 355.6 cents per million Btu, 22.0% higher than the December 1981 level.

29497 **(DOE/METC—83-57) IEA Grimethorpe Pressurized Fluidized-Bed Test Facility Test Series One report.** (NCB (IEA Grimethorpe) Ltd., Barnsley, South Yorkshire (UK)). Nov 1982. 519p. NTIS, PC A22/MF A01. Order Number DE83008940.

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Test Series 1 formed the first stage of the combustion research phase at the Grimethorpe Experimental Pressurized Fluidized Bed Combustion Facility. Following approximately 450 coal burning hours for commissioning the plant, the experimental program for Test Series 1 commenced in October 1981 and was completed in December 1981, and this involved a further total of approximately 400 h coal burning, which included 150 experimental h. The report provides a description of the Facility together with the data evaluation procedures, and also sets out the test plan and objectives for Test Series 1. The performance results are detailed together with analysis and evaluation of the data. Experiences gained during Test Series 1 suggest that the reliability and performance of the Facility can be improved and the report contains an outline of the modifications which are to be implemented prior to the start of the second Test Series, i.e., Test Series 2.

29498 **(DOE/RA/29353—1) Torsional fatigue life of power-plant-shaft material. Final report, Task I.** (Westinghouse Research and Development Center, Pittsburgh, PA (USA)). Sep 1982. Contract AC05-80RA29353. 172p. NTIS, PC A08/MF A01. Order Number DE83009313.

Research on the torsional fatigue life of power plant rotating shafts is reported. Grips, fixtures, and test specimens and apparatus were developed for materials testing under torsion-only and combined axial-torsion loading. A series of torsional fatigue tests, and also a series of axial fatigue tests, were done on shaft material. Existing Westinghouse computer codes (WECAN) were modified to allow elastic and plastic stress analysis of axisymmetric bodies in torison to be done by finite elements. Elastic analysis for a notched torsional specimen is complete. Extensive background analysis and literature review work was done and is reported in detail. Examination of the local strain approach to life prediction for notched members indicates that this approach is expected to be applicable to torsional loading. Based on existing limited data, straightforward modifications to account for state of stress effects appear to be sufficient. The effects of size and crack growth appear to be closely related, suggesting that current approaches to accounting for size effects need to be reconsidered.

29499 **(EPRI-CS/NP—2989) Modular Modeling System (MMS): a code for the dynamic simulation of fossil and nuclear power plants: overview and general theory. Final report.** Smith, L.P.; Dixon, R.R.; Shor, S.W.W. (Babcock and Wilcox Co., Lynchburg, VA (USA); Bechtel Group, Inc., San Francisco, CA (USA)). Mar 1983. 165p. NTIS, PC A08/MF A01. Order Number DE83901983.

The Modular Modeling System (MMS) is a computer code developed by EPRI to facilitate modeling the dynamics of fossil-fueled and nuclear steam electric power plants. It is intended to assist in the power plant design process and during later operation for troubleshooting, setting control system gains, validation of simulators, checking operating procedures, and forecasting the consequences of severe transient tests before they are actually run. The code is able at present to model fossil-fueled plants of almost all conventional configurations, pressurized water reactor (PWR) coolant systems, and the balance of plant of both boiling water reactor (BWR) and PWR plants. Enhancements scheduled for release in

early 1984 will permit the MMS to model BWR nuclear steam supply system components in normal operation and PWR reactor coolant systems which have been breached and are experiencing two-phase flow. The MMS provides preprogrammed modules that represent power plant components. These are automatically interconnected in the arrangement determined by the user by a high level simulation language which is an integral part of the MMS. The language also provides a run time executive, the integration algorithm, linear analysis routines, and many user convenience features. This report provides the theoretical basis of the MMS, a description of each module, and an executive summary that describes the present status of the code and its major features, together with the validation and testing that it has undergone. Full documentation of the MMS is found in the Computer Code Manual, which is available to users under license to EPRI.

29500 (EPRI-EA/EM—2893, pp 1.1-1.10) **Electric utility and cogeneration, post-PURPA.** Mitchell, R.C. III. (Arkansas Power and Light Co., Little Rock). Feb 1983. NTIS, PC A21/MF A01.

From EPRI cogeneration seminar; Berkeley, CA, USA (28 Jul 1982).

The effects of PURPA and FERC regulations on electrical utilities contemplating the conversion of existing industrial facilities or the building of new facilities for the cogeneration of electric power and steam are discussed in terms of financial impacts, fuel savings, amount of power generated, environmental impacts, and legislative requirements. The feasibility of converting some 1500 steam producing plants in the region served by the Arkansas Power and Light Co. to cogenerating or to coal-fueled plants was studied. It was concluded that major cogeneration investment commitments were unlikely due to the capital requirements, time expertise needed, environmental restrictions, and uncertainty about future regulations. (LCL)

29501 (EPRI-EA/EM—2893, pp 2.1-2.31) **Evaluation of dual energy use systems (DEUS).** Hu, S.D. (Electric Power Research Inst., Palo Alto, CA). Feb 1983. NTIS, PC A21/MF A01.

From EPRI cogeneration seminar; Berkeley, CA, USA (28 Jul 1982).

While the concept of DEUS is not new, recent studies sponsored by the US Department of Energy and others have pointed out the lack of adequate and reliable information to objectively evaluate the potential for DEUS, and the costs, benefits and impacts of DEUS implementation. In 1977, EPRI sponsored a DEUS Workshop to initiate a dialogue among utilities, industrial energy users, equipment manufacturers and government agencies relative to the development of a consistent and detailed resource base of information that would allow identification and evaluation of attractive DEUS options, and definition of the needed research, development and demonstration programs. The major findings of that Workshop were: an accurate evaluation of the potential for and the benefits of DEUS requires an evaluation of site-specific factors; utility perspectives must be properly represented in DEUS evaluation; cooperative efforts among industry and utilities are likely to lead to greater total benefits from DEUS; and a systematic evaluation of grid-integrated DEUS systems was needed. In early 1979, EPRI initiated this project to address the techno-economic and institutional aspects of DEUS. The principal objectives of this project are to: develop a methodology to assess DEUS options, giving explicit attention to utility perspectives and impacts; identify promising DEUS applications; identify and assess utility options for participation in DEUS; and identify research, development and demonstration needs and priorities. This report provides an overview of the project activities to date.

29502 (EPRI-EA/EM—2893, pp 3.1-3.69) **Overview of the DEUS screening and evaluation model.** Oplinger, J.L.; Priestley, R.R. (General Electric Co., Schenectady, NY). Feb 1983. NTIS, PC A21/MF A01.

From EPRI cogeneration seminar; Berkeley, CA, USA (28 Jul 1982).

The DEUS computer program was developed primarily as a screening tool to aid in cogeneration system selection and to perform site-specific evaluation of cogeneration economics. The DEUS program is designed to handle up to twelve systems including a nocogeneration base case system. The program contains a data base with sufficient data for one complete run with minimum user input. Values in the data base become default values unless they are superseded by other values specified via the program input. For a typical site-specific screening analysis, the user specifies data pertinent to the site, including utility rate data, comprising industrial rates and rates for utility purchases of electricity from cogenerators under Section 210 of the Public Utility Regulatory Policies Act (PURPA). The industrial heat and power requirements, as well as the utility rate data, can be specified in terms of time varying profiles. Other inputs include fuel types and costs, economic data, operational ground rules and ownership options (industrial, third-party and utility owned cogeneration plants can be considered). The program has the capability to evaluate systems using up to four fuel streams for two sizing options - one sized to match the maximum thermal load, the other having the power output specified by the user. The use of the DEUS program for evaluating the economics of a cogenerating system in comparison with a nocogeneration system is described.

29503 (EPRI-EA/EM—2893, pp 4.1-4.23) **Cogeneration Options Evaluation (COPE) model overview.** Limaye, D.R.; Venkateshwara, B. (Synergic Resources Corp., Bala Cynwyd, PA). Feb 1983. NTIS, PC A21/MF A01.

From EPRI cogeneration seminar; Berkeley, CA, USA (28 Jul 1982).

Cogeneration Options Evaluation (COPE) is a computer model designed to address the institutional and regulatory issues raised by cogeneration. COPE is a powerful evaluation tool that can help management examine attractive cogeneration options and choose an option that is best suited for a specific site under the relevant tax and fuel use regulations. An option here refers not only to different technologies, but also to different ownership structures and/or operating modes. For each option under consideration, COPE provides an analysis of the project's impact on the utility, the industry, and where appropriate, a third party. The objectives of COPE are to: evaluate, based on after-tax cash flows from cogeneration ventures, the financial and regulatory implications for the utility, the industry, and where relevant, third parties, for all practically feasible combinations of ownership and operating mode; trace, in terms of important dollar flows, the impacts of cogeneration ventures on the utility and the industry for all practically feasible combinations of ownership and operating mode; and provide information to potential project participants to identify mutually beneficial institutional arrangements for implementing cogeneration projects. The use of COPE is described.

29504 (EPRI-EA/EM—2893, pp 6.1-6.27) **Introduction to Arkansas Power and Light case study.** Alley, W. (Arkansas Power and Light Co., Little Rock). Feb 1983. NTIS, PC A21/MF A01.

From EPRI cogeneration seminar; Berkeley, CA, USA (28 Jul 1982).

The Arkansas Power and Light Company supplied information on the characteristics of an industrial plant located in their service territory for which cogeneration feasibility had been assessed previously. Cost and performance data were supplied for a coal-fired steam turbine and a natural gas-fired combined cycle system sized to meet the industrial plant's thermal load. The objectives of this case study were to: compare cost and performance data from the DEUS computer program's data base with the information supplied by AP and L; calculate the buyback rate necessary, as a function of the industrial plant's cost of steam, to provide a third party owner of a cogeneration system with an internal rate of return of 25%; and examine, in the case of the combined cycled system, the impact of alternative capital structures and debt service arrangements provided by Arkansas Power and Light. For the combined cycle system, the Cogeneration Options Evaluation (COPE) computer program, was used to examine alternative capital structures and debt service arrangements. The conclusions of this study were that: the DEUS computer program's data base is useful for screening applications and can be modified to evaluate specific system designs; combined cycle system economic feasibility is less sensitive to the cost of steam than steam turbine systems; cogeneration system economics are very sensitive to the cost of fuel; for a given cost of steam, a long cogeneration system operating life de-

creases the buyback rate required to earn a 25% IRR; and the high debt fraction increases rate of return significantly in some cases.

29505 (EPRI-EA/EM—2893, pp 7.1-7.19) **Georgia Power Company cogeneration case study.** Feb 1983. NTIS, PC A21/MF A01.

From EPRI cogeneration seminar; Berkeley, CA, USA (28 Jul 1982).

This case study involves an industrial steam user in the service territory of the Georgia Power Company. The focus of this case is an evaluation, using DEUS, of alternative greenfield steam generation systems available to the industry. The options include a number of cogeneration technologies and a conventional boiler. Only technologies using coal as input fuel are considered. Moreover, the capital costs for each steam generation system do not include costs for flue gas desulfurization. This is based on site-specific environmental regulations. The questions examined included: what is the most economic steam generation system from the industry's standpoint; what price of steam would make the investment for a new coal-fired boiler yield an internal rate of return of 25%; what is the impact of higher electricity buyback rates on the industry's choice among the different steam generation options; which would be the best cogeneration system; the relative advantages/disadvantages of third party ownership; and what are the implications of 100% utility ownership. The important conclusions from this case study were: low buyback (PURPA) rates make cogeneration systems less attractive than conventional boilers; under current circumstances, a conventional boiler is the best steam generation system; among the coal-fired cogeneration systems, a cogeneration topping cycle with a turbine inlet pressure of 1465 psi and a conventional boiler (STB 1465) is the best steam generation system and offers the highest net present value and rate of return on investment; and the relative attractiveness of cogeneration systems that use an atmospheric fluidized bed (AFB) combustor instead of a conventional boiler is sharply diminished if site-specific environmental regulations do not require flue gas desulfurization for conventional boiler systems. (LCL)

29506 (EPRI-EA/EM—2893, pp 8.1-8.16) **Introduction of PG and E/Kaiser Engineers case study.** Coyle, J. (Raymond Kaiser Engineers Inc., Oakland, CA). Feb 1983. NTIS, PC A21/MF A01.

From EPRI cogeneration seminar; Berkeley, CA, USA (28 Jul 1982).

Information is provided on a potential cogeneration site in the Pacific Gas and Electric Company's service territory. The site is a major food processing plant in northern California. The objectives of this case study were to: evaluate the economic feasibility of a gas turbine and heat recovery steam generator cogeneration system sized to supply 20,000 lb/h of steam; evaluate the economic feasibility of supplying more than 20,000 lb/h; compare the impact of PG and E's as delivered energy and capacity buyback rate and PG and E's as delivered energy and firm capacity buyback rate on cogeneration system feasibility; assess the feasibility of increasing power generating capacity; and compare the DEUS computer program's performance data with performance data supplied by Kaiser Engineers. The study showed that: the generic system design performance data in the DEUS computer program approximates the design performance of the system selected by Kaiser engineers; there is no economic advantage to sizing a system to produce more than 20,000 lb/h; and increasing generating capacity may result in a higher Internal Rate of Return, IRR; based on the economic groundrules used in this case study, the as-delivered energy and capacity buyback rate results in a higher IRR.

29507 (EPRI-EA/EM—2893, pp 9.1-9.32) **Introduction to Carolina Power and Light case study.** Glasgow, J. (Carolina Power and Light Co., Raleigh, NC). Feb 1983. NTIS, PC A21/MF A01.

From EPRI cogeneration seminar; Berkeley, CA, USA (28 Jul 1982).

A chemical plant is scheduled to begin operation within the service territory of the Carolina Power and Light Company (CP and L) in 1984. Both the plant owner and CP and L were interested in assessing cogeneration feasibility. Fuels available at the site include coal, peat and natural gas. The objectives of this case study were to: evaluate the economic feasibility of steam turbine cogeneration systems for industrial, third party and utility ownership; assess the benefits to the cogeneration system owner of signing a multiyear power sales agreement to qualify for CP and L's proposed levelized buyback rates; determine whether it would be more beneficial to shut the plant down for the month of May rather than August, as is now planned; and determine whether cogeneration system electrical generating capacity greater than that available from a thermal load following system is warranted. The data used and results obtained with the DEUS program are presented. It was concluded that: cogeneration is economic in the CP and L service territory; the IRR's achievable with coal-fired systems with and without flue gas desulfurization and peat-fired systems are comparable, but coal-fired systems without flue gas desulfurization are the least capital intensive; the benefits achievable by rescheduling the annual plant shutdown are not significant; a cogeneration system owner can benefit by signing a power sales agreement to obtain a longterm levelized rate; sizing a cogeneration system for a power generating capacity greater than that available from a thermal sized/thermal load following system is not economic; and properly structured partnerships can result in projects that are beneficial to both CP and L and industry. (LCL)

29508 (EPRI-EA/EM—2893, pp 10.1-10.45) **Overview of the COGEN2 model.** Feb 1983. NTIS, PC A21/MF A01.

From EPRI cogeneration seminar; Berkeley, CA, USA (28 Jul 1982).

A series of slides are presented which contain written material describing the COGEN2 computer program, its inputs and outputs, potential uses and a use example, and the current status of the program. By simulating the technical and economic performance of cogenerating facilities, COGEN2 can be used by individual electric utilities for screening studies to identify potential cogenerators; preliminary designs of cogenerating plants; technical assistance to utility customers; load management studies; rate design studies; and rate negotiations with cogenerators. (LCL)

29509 (EPRI-EA/EM—2893, pp 11.1-11.11) **Alabama Power Company case study: summary of technical details.** Manuel, E.H. Jr. (Mathtech, Inc., Princeton, NJ). Feb 1983. NTIS, PC A21/MF A01.

From EPRI cogeneration seminar; Berkeley, CA, USA (28 Jul 1982).

A pulp mill within Alabama Power's service territory is adding production capacity and accompanying power generation capability. The existing mill requires 16 MW of power, 6 MW from Alabama Power and 10 MW produced on-site with extraction turbine. The fuel is 90% wood, bark and black liquor. The expanded mill will require 25 MW of power and additional boiler capacity. The customer is also adding new 30 MW extraction turbine. The objectives of this study were to: estimate the cost savings, if any, provided by the additional extraction turbine; compare the first year cost savings with the cost savings over the longer term; and assess whether the level of cogeneration and electricity sales by the customer is influenced by availability of capacity credit from Alabama Power. The analysis method is described and the results are presented. The study conclusions are: the new extraction turbine appears to be an attractive investment which for a capital investment in the $8 to $10 million range will generate cost savings estimated at more than $5 million per year; however, available data did not permit a definitive analysis because load variations were not known and the differential cost of higher pressure steam generation was not known; and the availability of a capacity credit influences electricity sales and purchases, but, in the range considered, the capacity credit does not influence the level of cogeneration.

29510 (EPRI-EA/EM—2893, pp 12.1-12.29) **Georgia Power Company case study: summary of technical details.** Manuel, E.H. Jr. (Mathtech, Inc., Princeton, NJ). Feb 1983. NTIS, PC A21/MF A01.

From EPRI cogeneration seminar; Berkeley, CA, USA (28 Jul 1982).

Georgia Power Co. requested the analysis of cogeneration at a proposed industrial park including six manufacturing plants with a total electric load of 100 to 165 MW and a total steam load of 2079 to 2816 million Btu/h. An earlier study developed conceptual design incorporating conventional coal boilers with supplemental

wood firing, steam turbine generators, and flue gas desulfurization. No cost estimates were developed in the earlier study. The purpose of this study were to determine: if cogeneration is economical and, if so, what is the economically optimal design for the cogeneration system; what are the cost savings available with cogeneration compared to the no-cogeneration case; and what impact do reliability; availability requirements have on equipment selection and plant cost. The method of analysis and results obtained are described. The study concluded that: cogeneration is economical way to supply steam and electricity to the industrial park; COGEN2 developed a complex system design involving two turbine types, two boiler types, selection of turbine throttle, extraction and exhaust pressures, reliability constraints, and three process steam pressure lines; and reliability considerations have measurable impact on both system design and cost. (LCL)

29511 (EPRI-EA/EM—2893, pp 13.1-13.17) **Northeast Utilities case study: summary of technical details.** Manuel, E.H. Jr. (Mathtech, Inc., Princeton, NJ). Feb 1983. NTIS, PC A21/MF A01.

From EPRI cogeneration seminar; Berkeley, CA, USA (28 Jul 1982).

Northeast Utilities asked for a screening study of the cogeneration potential at 11 customer facilities which included: nine manufacturing plants, one hospital, and one university. All but one facility are in the small to medium energy size range with a peak electric demand of 1 to 5 MW and a peak steam demand of 10,000 to 50,000 lbs h. None of the customers currently does cogeneration. The objectives of this study were to assess, on a preliminary basis, whether cogeneration would be economical at any of the facilities, and to provide supporting documentation for Northeast Utilities to use in further discussions with the customers. The method of analysis used, the characteristics of each of the 11 facilities, and the results of the study are presented. At 3 of the 11 facilities, use of some cogeneration could provide overall cost savings. However, the savings are appreciable at only one facility; natural gas-fired gas turbines were the most economical systems at the three facilities; and, at all three facilities where cogeneration was attractive, the sale of cogenerated electricity was also attractive.

29512 (EPRI-EA/EM—2893, pp 14.1-14.18) **Pacific Gas and Electric Company case study: summary of technical details.** Manuel, E.H. Jr. (Mathtech, Inc., Princeton, NJ). Feb 1983. NTIS, PC A21/MF A01.

From EPRI cogeneration seminar; Berkeley, CA, USA (28 Jul 1982).

PG and E owns and operates a district steam-heating system in downtown San Francisco. This system currently uses natural gas/oil-fired boilers, has a variable steam load of 27,000 to 225,000 lbs/h, and generates no electric power. PG and E requested an analysis of adding cogeneration capability to the system using gas turbine cogeneration as the near-term option and steam turbine cogeneration with coal or RDF as the longer-term option. The steam demand projections, equipment alternatives considered, fuel and electric power price forecasts, method of analysis used, and results obtained are described. From this analysis it was concluded that: gas turbine cogeneration could provide substantial cost savings (up to 40%); approximately 10 MW of net capacity would be most economical; continued use of some existing boiler capacity would be desirable; assumption of 90% availability for cogeneration plant increases cost by 8.5% over 100% availability; and steam turbine systems using coal or RDF would also be economical.

29513 (EPRI-EA/EM—2893, pp 15.1-15.37) **Overview of the in-plant generation forecasting model (IPGFM).** Manuel, E.H. Jr. (Mathtech, Inc., Princeton, NJ). Feb 1983. NTIS, PC A21/MF A01.

From EPRI cogeneration seminar; Berkeley, CA, USA (28 Jul 1982).

The In-Plant Generation Forecasting Model (IPGFM) was developed to forecast the use of purchased and self-generated electricity by the manufacturing sector. Forecasts are produced for the 9 census regions and for the US for the forecast time period of 1975-2000. The industries covered include: pulp and paper; chemicals; petroleum refining; primary metals; and all other manufacturing as a residual category. The key objectives during IPGFM development were to formulate the model in a way which would allow EPRI to vary many of the important model in assumptions, to design the model to take into account technical, economic and institutional factors, and to calibrate the model against actual data on industry behavior. The characteristics and applications of the IPGFM model are compared with those of COGEN2, and the regulatory and economic variables involved in using IPGFM are described. The results obtained are compared with COGEN2 forecast results. The capabilities and limitations of IPGFM are summarized. (LCL)

29514 (EPRI-EA/EM—2893, pp 16.1-16.60) **Description of team-up.** Feb 1983. NTIS, PC A21/MF A01.

From EPRI cogeneration seminar; Berkeley, CA, USA (28 Jul 1982).

The goals of Project Team-Up are to foster the use of selected EPRI- or utility-developed energy analysis models by utility users. To achieve this goal, Battelle has agreed to perform the following tasks: establish a project office at Battelle Columbus Laboratories; develop a system for the standardization and uniform documentation of such models; operate a central interactive library of selected models for remote access, testing and evaluation; demonstrate the transferrability of machine independent, standard copies of the models for in-house utility use; provide assistance to utility users of the models; and conduct training seminars. The development of this project, the data base structure, and model documentation and usage are discussed. (LCL)

29515 **(EPRI-EM—2946-SR) Utility battery operations and applications.** (Electric Power Research Inst., Palo Alto, CA (USA)). Mar 1983. 67p. NTIS, PC A04/MF A01. Order Number DE83901967.

This report on Utility Battery Operations and Applications, with sections prepared and/or reviewed by utility personnel, has been compiled for use by utility personnel and, more particularly, for use by battery developers to provide a common basis for battery design approaches and operational opportunities. The report considers three aspects: operational requirements - the desired approaches to operating batteries in a utility system are described and the impact of these approaches on battery requirements is reviewed; value and design considerations - the value of battery systems is estimated and approaches are recommended to determine tradeoffs among capital cost, design, availability, performance, and maintenance to achieve a cost-optimized system; and siting considerations - economics, benefits, requirements, and safety guidelines are proposed for siting batteries in utility systems and in utility-customer locations. The battery design and operating approaches described in this report are based upon common practices of the utility industry. In several cases, extrapolations of industry practice are presented to account for gaps in knowledge that exist because batteries are not being used for bulk energy storage, and therefore, utilities have not considered, in depth, the implication of their unique operational features.

29516 **(IBRD-WP—286) Shadow pricing and power tariff policy. Staff working paper.** Munasinghe, M.; Warford, J.J. (International Bank for Reconstruction and Development, Washington, DC (USA)). Jun 1978. 38p. NTIS, PC A03/MF A01.

This paper discusses the details of a two-step procedure designed to compensate for the effect of distortions on the electric power sector. It examines the computation of basic marginal costs by direct use of appropriate shadow prices to correct for readily quantifiable market distortions, considering the adjustment of such basic marginal costs to reflect other social and economic constraints.

29517 **(PNL—4564) Pre-test geological and geochemical evaluation of the Caprock, St. Peter Sandstone and formation fluids, Yakley Field, Pike County, Illinois.** (PB-KBB, Inc., Houston, TX (USA)). Mar 1983. Contract AC06-76RL01830. 265p. NTIS, PC A12/MF A01. Order Number DE83010625.

The goal of these studies is to ensure long-term stable containment of air in the underground reservoirs used in conjunction with compressed air energy storage (CAES) plants. The specific

objective is to develop stability criteria and engineering guidelines for designing CAES reservoirs in each of the three major reservoir types, including aquifers, salt cavities, and mined hard rock caverns. This document characterizes the geologic nature of porous media constituents native to the aquifer field test site near Pittsfield, Illinois. The geologic samples were subjected to geochemical evaluations to determine anticipated responses to cyclic air injection, heating and moisture - conditions typical of an operating CAES reservoir. This report documents the procedures used and results obtained from these analyses.

29518 **Transient stability enhancement of electric power generating systems by 120-degree phase rotation.** Cresap, R.L.; Kreipe, M.J.; Taylor, C.W. (to Dept. of Energy). US Patent 4,333,021. 1 Jun 1982. Filed date 12 May 1980. vp. PAT-APPL-148863.

A method and system for enhancing the transient stability of an intertied three-phase electric power generating system. A set of power exporting generators is connected to a set of power importing generators. When a transient cannot be controlled by conventional stability controls, and imminent loss of synchronism is detected (Such as when the equivalent rotor angle difference between the two generator sets exceeds a predetermined value, such as 150 degrees), the intertie is disconnected by circuit breakers. Then a switch having a 120-degree phase rotation, or a circuit breaker having a 120-degree phase rotation is placed in the intertie. The intertie is then reconnected. This results in a 120-degree reduction in the equivalent rotor angle difference between the two generator sets, making the system more stable and allowing more time for the conventional controls to stabilize the transient.

29519 **Status report - advanced heat exchanger technology for a CCGT power generation system.** Wright, D.E.; Tignac, L.L. (Rockwell Int, Canoga Park, CA, USA). *American Society of Mechanical Engineers, [Paper];* No. 82-GT-164, 1-8(1982). (CONF-820407—).

From 27. ASME international gas turbine conference; London, UK (18 Apr 1982).

This report gives laboratory and field test results of a specially designed heat exchanger for coal-fired power plants. The system incorporates an atmospheric fluidized bed and combustion system for pulverized coal. The heat exchanger was made from both metallic and ceramic materials.

29520 **Design of a 6- by 6-foot coal-fired heater for a CCGT air heater.** Russell, L.H.; Campbell, J. Jr. (Rockwell Int, Canoga Park, CA, USA). *American Society of Mechanical Engineers, [Paper];* No. 82-GT-171, 1-8(1982). (CONF-820407—).

From 27. ASME international gas turbine conference; London, UK (18 Apr 1982).

Coal-fired heaters for closed-cycle gas turbine have been designed and tested. One of the heater concepts employs the atmospheric pressure fluidized bed coal combustion process. The paper describes a research-oriented bed for the research program. Details are described and discussed of such heaters for cogeneration applications. 2 refs.

29521 **Determination of saturated values of rotating machinery incremental and apparent inductances by an energy perturbation method.** Nehl, T.W.; Fouad, F.A.; Demerdash, N.A. (Va Polytech Inst & State Univ, Blacksburg, USA). pp 9p, Paper 82WM 237-6 of IEEE Power Engineering Society winter meeting. New York, NY; IEEE (1982).

From IEEE Power Engineering Society winter meeting; New York, NY, USA (30 Jan 1982).

The accurate calculation of machine winding apparent and incremental inductances and their variation with saturation and rotor angle is crucial to the dynamic analysis of such devices. Energy and winding current perturbations form the basis of a method for calculating of the saturated apparent and incremental inductances of rotating machinery as functions of rotor position and machine winding excitation currents. The method is totally general and utilizes numerical field calculation techniques in obtaining stored energy in the magnetic circuits of such machines. Thus, it can be applied to a wide class of machinery with practically any cross-sectional contours and number of windings. It can be used at any given set of excitations (any loads). This method was applied to the calculation of the apparent and incremental inductances of a 15 hp samarium cobalt permanent magnet synchronous machine. The necessary numerical field solutions were obtained by finite elements at both rated an no load conditions. The calculated inductances, at various rotor positions, were compared with those obtained during laboratory measurements and the agreement between calculated and measured values was consistently very good. The advantage of this method over the more traditional calculations of only the direct and quadrature axes inductances (or reactances, including transient and subtransient components) is that the entire N XN matric of incremental inductances that truely govern the dynamic performance of an N-winding machine can be detemined regardless of the validity of a rotating D-Q-O frame of reference. 19 refs.

29522 **Special losses in rotors of electronically commutate brushless dc motors induced by non-uniformly rotating armature MMFS.** Nagarkatti, A.K.; Demerdash, N.A.; Mohammed, O.A. (Va Polytech Inst & State Univ, Blacksburg, USA). pp 5p, Paper 82WM 242-6 of IEEE Power Engineering Society winter meeting. New York, NY; IEEE (1982).

From IEEE Power Engineering Society winter meeting; New York, NY, USA (30 Jan 1982).

This paper analyzes special eddy current losses induced in the rotor of an electronically commutated permanent magnet powered from a d.c. source, on account of the non-uniform rotation of the stator field. Formulas are established for the losses induced by the tangential component of the stator magnetic field. These formulas are applied to a specific motor design in which the magnet retainment is accomplished by means of a metallic nonmagnetic stainless steel sleeve surrounding the rotor structure. The resulting losses are given with consequent conclusions. 6 refs.

29523 **Optimal operating policy for energy storage.** Lukic, V.P. (Case West Reserve Univ, Cleveland, Ohio, USA). pp 8p, Paper 82WM 125-3 of IEEE Power Engineering Society winter meeting. New York, NY; IEEE (1982).

From IEEE Power Engineering Society winter meeting; New York, NY, USA (30 Jan 1982).

This paper deals with a procedure for solution to optimal economical operation of an integrated power system containing energy storage units with system transmission losses included. Dynamic programming is used for solving this problem, defined as a multistage decision process with complex restrictions. An iterative method of solution based on the application of the relaxation method is developed to generate the optimal solution to the system operations. Two examples illustrate the method: an electrical generating system of one storage unit and one supplementary with two energy storage units and one supplementary thermal plant. 5 refs.

29524 **Simulating central battery storage using a levelized incremental cost method.** Sullivan, E.L. (Univ of Fla, Gainesville, USA). pp 6p, Paper 82WM 136-0 of IEEE Power Engineering Society winter meeting. New York, NY; IEEE (1982).

From IEEE Power Engineering Society winter meeting; New York, NY, USA (30 Jan 1982).

This paper describes a methodology for including central battery storage in hourly production simulation computer programs. As such, these simulation tools calculate detailed production statistics by modeling the hour by hour operation of a power system over the planning horizon. By integrating the hourly operation of central storage into the unit commitment and economic dispatch routines, production analysis codes can be used to assess the production credits associated with the storage technologies. These credits can then be used to value central storage by determining the pesent worth production costs with and without storage over the planning horizon. The methodology proposed dispatches the generation system and central storage in a way that levelizes the incremental cost of poduction over a predefined interval of time. The premise is, that if the incremental cost of energy is the same for each hour in the interval that the production costs over the interval will be a minimum. Formulated as a Kuhn-Tucker constrained optimization problem, the charging and discharging rate constraints can easily be satisfied. Further, the Kuhn-Tucker dual variables can be used to determine the extent to whiaxing the constraints on charge

and discharge rates. A simple example is presented to demonstrate the effectiveness of the method in determining levelized incremental cost operating strategies for a system with central storage. 4 refs.

2002 Environmental Aspects

REFER ALSO TO CITATION(S) 28863, 28865, 28870, 28970, 30394

29525 **(AD-A—123069/7) Suppression of ice fog from the Fort Wainwright, Alaska, cooling pond. Special report.** Walker, K.E.; Brunner, W. (Cold Regions Research and Engineering Lab., Hanover, NH (USA)). Oct 1982. 39p. NTIS, PC A03/MF A01.

Ice fog near the Ft. Wainwright cooling pond creates a visibility hazard. Observations show a substantial reduction in visibility along both private and public roadways in the path of the cooling pond's ice fog plume. This reduction in visibility increases as the ambient air temperature decreases. Visibility was less than 215 m (700 ft) on the Richardson Highway on the average of 8 days for each of the 3 data years. Data collected during the winters of 1979-80, 1980-81 and 1981-82 statistically show that use of a monomolecular film evaporation suppressant, hexadecanol (C16H33OH), on the pond to reduce ice fog is ineffective. There is an immediate need for a driver warning system when visibility is affected by the ice fog.

29526 **(ANL/FE—82-24) Alkali-metal-vapor removal from pressurized fluidized-bed-combustor flue gas. Annual report, October 1981-September 1982.** Lee, S.H.D.; Myles, K.M.; Jonke, A.A. (Argonne National Lab., IL (USA)). Mar 1983. Contract W-31-109-ENG-38. 27p. NTIS, PC A03/MF A01. Order Number DE83010689.

This work supports the program to develop sorbents for the cleanup of gases from pressurized fluidized-bed coal combustion (PFBC) so that the cleaned hot gases can be used to power downstream gas turbines without causing corrosion. A simulated PFBC flue gas containing NaCl vapor was used to characterize activated bauxite and diatomaceous earth at a bed temperature of 905°C and a system pressure of 10 atm absolute. The NaCl vapor was found to be captured by activated bauxite essentially as sodium sulfate, with a small fraction captured as sodium chloride. In contrast, diatomaceous earth captured NaCl vapor by a combined result of (1) a chemical reaction that converts the vapor into condensed sodium sulfate and (2) chemical reactions that transform the captured sodium into water-insoluble silicate compounds. In NaCl-vapor sorption efficiency studies, a 12.7-cm-long activated bauxite bed was tested for 12 h in a gas stream containing 4 to 8 ppmV NaCl-vapor concentration, and >99.8% NaCl-vapor sorption efficiency was achieved. This efficiency compared with 99.1 and 95.3% obtained by a diatomaceous earth bed of the same length tested for 8 h in gas streams containing 28 and 2 ppmV NaCl-vapor concentration, respectively. The addition of HCl to the simulated flue gas had an insignificant effect on the NaCl-vapor sorption behavior and efficiency of activated bauxite. Experimental results are also presented on (1) the water leachability of the sodium captured on activated bauxite, (2) the partial conversion to sodium sulfate of the NaCl sample used as the vapor source for the sorption tests, and (3) the changes in the chemical and physical properties of both sorbents as a result of exposure to the simulated flue gas.

29527 **U.S. Department of Energy 60-Hz fields bioeffects research.** Bulawka, A.O.; Wisecup, W.G.; Rosen, L.A.; Feero, W.E.; Dietrich, F.M. (US DOE, Washington, DC, USA). pp 7p, Paper 82WM 220-2 of IEEE Power Engineering Society winter meeting. New York, NY; IEEE (1982).

From IEEE Power Engineering Society winter meeting; New York, NY, USA (30 Jan 1982).

Major difficulities exist in reliably evaluating the consequences of human and animal exposure to electric fields from transmission lines: lack of experimental and epidemiological data on human exposures, insufficient data from experimental animals, lack of an understanding of an understanding of the basic mechanisms by which low-intensity fields interact with biological systems, and problems in extrapolating data from animals to humans. Research to date has not resolved these difficulties, but it has led to significant advanced in methodologies and an accumulation of effects data. This paper summarizes the results of the last 5 years of DOE research in this area. 58 refs.

2003 Power Transmission And Distribution

REFER ALSO TO CITATION(S) 29521, 29776, 30114

29528 **(DOE/ET/29069—T1) Evaluation of advanced technologies for power transformers. Final report, Part 2, June 1, 1979-June 30, 1981.** Atkins, J.M.; Reed, C.W.; Holmes, D.G.; Csendes, Z.J.; Chari, M.V.K.; Lyke, A.J.; McIver, J.C.; Polumbo, W.J.; Rathbun, W.H.; Slocik, J.P. (General Electric Co., Schenectady, NY (USA). Corporate Research and Development Dept.). 30 Jun 1981. Contract AC01-77ET29069. 107p. NTIS, PC A06/MF A01. Order Number DE83010017.

The object of this Department of Energy program has been to further develop and refine the following technologies for incorporation into the design of power transformers: sheet-wound coils; compressed gas and polymer film insulation; and sealed, forced-liquid cooling. The work carried out during a 15 month-period is reported and covers the following areas: 60 Hz and impulse breakdown measurements on small (6 in. size) sheet-wound coils built on a new coil winding apparatus; analysis of the forces associated with short-circuit currents in sheet windings and the design, construction, and testing of sheet-wound model coils; application of axisymmetric finite element magnetic field analysis to sheet-wound transformer designs; analytical studies of transformer designs based on the proposed concepts; and preliminary study of the possible manufacturing technology requirements associated with sheet-wound gas-insulated transformers. Progress and accomplishments in each of the activities are discussed.

29529 **(EPRI-EL—2890-Vol.1) Transverse-field vacuum interrupter. Volume 1. Development of a metallic return-transfer breaker.** Gorman, J.G.; Voshall, R.E.; Wien, R.E.; Chien, Y.K.; Roote, J.C.; Innis, R. (Westinghouse Electric Corp., Pittsburgh, PA (USA). Research and Development Center). Mar 1983. 154p. NTIS, PC A08/MF A01. Order Number DE83901937.

A novel high-voltage dc breaker designed for the Bonneville Power Administrtion (BPA) and installed by BPA at its Celilo, Oregon converter station has been shown in field trials to be capable of interrupting up to 1700-A dc against a recovery voltage of 80 kV. The breaker, which is known as a Metallic Return Transfer Breaker (MRTB), changes the mode of operation of the Pacific Intertie (+- 400 kV dc, 850 miles long) from monopolar ground return to monopolar metallic return without deenergizing the dc system. MRTB combines two technologies: the first is a prototype 72-kV vacuum interrupter developed by Westinghouse R & D; the other is a vacuum arc current limiter prototype device developed under an ongoing EPRI contract RP564-1 and -2. The two are connected in series, with a 10-μF capacitor in parallel with the series connected devices. The MRTB can switch dc currents up to 2.5 kA against a recovery voltage of 85 kV. Advantages of the technique used in this breaker design are insensitivity to circuit current polarity and isolation of the current-zero-producing magnetic field from circuit potential.

29530 **(EPRI-EL—2890-Vol.2) Transverse-field vacuum interrupter. Volume 2. Development of a vacuum arc current limiter. Phase III: the conceptual design and rating of a 145-kV FCL. Final report.** Gorman, J.G.; Bonk, J.J.; Voshall, R.E.; Chien, Y.K.; Innis, R. (Westinghouse Electric Corp., Pittsburgh, PA (USA). Research and Development Center). Mar 1983. 143p. NTIS, PC A07/MF A01. Order Number DE83901936.

Portions are illegible in microfiche products.

Phase 3 of this research project developed a conceptual design and rating for a 145-kV fault current limiter (FCL). The design uses two 72-kV modules in series, each of which in turn uses two commutation devices and a conventional vacuum interrupter in series. These three devices are paralleled by a 25 μF capacitor and a metal oxide nonlinear resistor having a clamping voltage of 62.5 kV. This arrangement has a capability extrapolated from experi-

ments of commutating currents greater than 16 kA (instantaneous). Analyses involving assumptions about the sensor and actuator characteristics indicated tht the 145-kV FCL could limit the worst fault from a source capable of producing 15-kA rms fault current. In the event of failure to limit the first loop of fault current, the presence of the series-connected vacuum interrupter assures a first current zero limitation of the fault. Application and system analysis showed that no source feeding a 145-kV/15-kA FCL is likely to exceed 15-kA rms fault current. The design parameters of the major components are specified, and their embodiment into a 145-kV/15-kA FCL are described. While an FCL could now be built for field testing, it is recommended that a Phase 4 program be carried out to simplify the commutation device and to optimize the cost effectiveness of the 145-kV FCL.

29531 **New solid-state valves for HVDC.** Douglas, J. *EPRI (Electric Power Research Institute) Journal;* **8**: No. 1, 14-19(Jan-Feb 1983).

Expensive terminals precluded the use of high-voltage direct-current (HVDC) equipment until recent improvement introduced the light-fired solid-state thyristor and a two-stage evaporative cooling system made conversion from alternating current to direct current cost-effective. The Electric Power Research Institute's (EPRI's) 13 HVDC projects will begin a two-year demonstration this year at the Sylmar converter station in conjunction with General Electric and the Los Angeles Department of Water and Power. If successful, the system will replace the Pacific Intertie Line. Other programs will investigate equipment self-protection and reliability. 1 figure. (DCK)

29532 **Communication systems for distribution automation and load management.** Blair, W.E.; Rhyne, V.T. (EPRI). *IEEE (Institute of Electrical and Electronics Engineers) Transactions on Power Apparatus and Systems;* **PAS-101**: No. 7, 1888-1893(Jul 1982).

The Electric Power Research Institute and the U.S. Department of Energy have completed a jointly sponsored program to develop and test communication systems for distribution automation and load management. The program included three powerline-carrier projects, an ultra-high-frequency radio project, and a telephone project. For each project, a two-way (half-duplex) digital communication system was developed to perform such functions as fault location and isolation, distribution feeder switching, load control, time-of-day metering, remote meter reading, and equipment monitoring. The results of this research indicate that communication systems in all three technologies (power line carrier, radio, and telephone) have advanced closer to satisfying utility requirements for distribution automation and load control. Research will continue to determine whether these technologies will be cost-effective.

29533 **The detection of incipient faults in transmission cables using time domain reflectometry techniques: technical challenges.** Anderson, W.E.; Ondrejka, A.R.; Ramboz, J.D. (NBS). *IEEE (Institute of Electrical and Electronics Engineers) Transactions on Power Apparatus and Systems;* **PAS-101**: No. 7, 1928-1934(Jul 1982).

The location and repair of faults in underground transmission lines is a difficult and time-consuming operation. The Department of Energy has sponsored research in the development of instrumentation to detect and locate incipient fault sites. Some of these methods rely on reflectometry techniques in either the time or frequency domain. NBS has investigated the feasibility of using such methods in extruded polyethylene cables.

29534 **Static reactive compensator for power transmission systems.** Byerly, R.T.; Poznaniak, D.T.; Taylor, E.R. Jr. (Westinghouse Electr Corp, Pittsburgh, PA, USA). pp 9p, Paper 82WM 179-0 of IEEE Power Engineering Society winter meeting. New York, NY; IEEE (1982).

From IEEE Power Engineering Society winter meeting; New York, NY, USA (30 Jan 1982).

The static VAR compensator (SVC) is an integrated system of static electrical components (e.g. capacitors, reactors, transformers, and switches) combined in such manner to provide rapid, continuously controllable shunt reactive power compensation. Emphasis is placed on stability, and it is shown that SVCs can provide significant benefits in terms of increased transient stability limits and improved damping for synchronizing power flow oscillations. The paper includes descriptions of static VAR compensators, with technical and economic comparisons of different compensators. An SVC system study model is presented which includes provision for modulating reactive compensation in response to a variety of system functions. Study procedures are illustrated which relate system stability objectives to general specifications of SVCs, including their locations, regulating slopes, peak reactive power requirements, and modulation control. This paper is based on the final report of a study funded by the Department of Energy the Los Alamos Scientific Laboratory. 14 refs.

29535 **Digital simulation of static VAR system transients.** Lasseter, R.H.; Lee, S.Y. (Univ of Wis, Madison, USA). pp 7p, Paper 82WM 178-2 of IEEE Power Engineering Society winter meeting. New York, NY; IEEE (1982).

From IEEE Power Engineering Society winter meeting; New York, NY, USA (30 Jan 1982).

This paper describes digital simulation of static VAR system transients. Methods are described for simultaneous digital simulation of thyristors, their gate pulse generating circuit, the regulating circuit, and the power system. Results are presents showing a voltage regulator's response to voltage changes and faults. 9 refs.

29536 **System restoration - deploying the plan.** Johnson, W.A.; Prabhakara, F.S.; Torri, J.F.; Niessink, T.; Gates, J.J.; Stovall, J.P.; Whitmire, C.N.; Mills, L.; Rodrigue, J.C. pp 9p, Paper 82WM 165-10 of IEEE Power Engineering Society winter meeting. New York, NY; IEEE (1982).

From IEEE Power Engineering Society winter meeting; New York, NY, USA (30 Jan 1982).

21 NUCLEAR POWER PLANTS

REFER ALSO TO CITATION(S) 29617

2101 Power Reactors, Non-breeding, Light-water Moderated, Boiling Water Cooled

REFER ALSO TO CITATION(S) 29117, 29143, 29206, 29595, 29596, 29635, 29641, 29642, 29643, 29644, 29650, 29654, 29661, 29662, 29663, 29664, 29665, 29666, 29669, 29679, 29680, 29681, 29683, 29684, 29686, 29688, 29690, 29698

29537 **(CONF-830225—3) Reactors and fuel production.** Kasten, P.R. (Oak Ridge National Lab., TN (USA)). 1983. Contract W-7405-ENG-26. 87p. NTIS, PC A05/MF A01. Order Number DE83901523.

From Nuclear fuel cycle information workshop; Oak Ridge, TN, USA (15 Feb 1983).

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Design characteristics and fuel cycle parameters are compared for PWR, BWR, HTGR, GCFR, PHWR, and LMFBR type reactors.

29538 **(CONF-830439—2) Local void and slip model used in BODYFIT-2PE.** Chen, B.C.J.; Chien, T.H.; Kim, J.H.; Lellouche, G.S. (Argonne National Lab., IL (USA); Electric Power Research Inst., Palo Alto, CA (USA)). 1983. Contract W-31-109-ENG-38. 12p. NTIS, PC A02/MF A01. Order Number DE83010581.

From 3. multi-phase flow and heat transfer symposium; Miami, FL, USA (18 Apr 1983).

A local void and slip model has been proposed for a two-phase flow without the need of fitting any empirical parameters. This model is based on the assumption that all bubbles have reached their terminal rise velocities in the two-phase region. This simple model seems to provide reasonable calculational results when compared with the experimental data and other void and slip models. It provides a means to account for the void and slip of a two-phase flow on a local basis. This is particularly suitable for a fine mesh thermal-hydraulic computer program such as BODYFIT-2PE.

29539 **(DOE/ET/34031—6) Extended Fuel-Burnup Program: cold critical measurement performed before Cycle 8 startup at Monticello reactor.** Rose, P.C. (General Electric Co., Lynchburg, VA (USA)). Jan 1983. Contract AC02-80ET34031. 56p. (GEAP—30055). NTIS (US Sales Only), MF A01. Order Number DE83010895.

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Cold neutron flux shapes become more strongly peaked to the top of a Boiling Water Reactor (BWR) and design for effective cold shutdown margin becomes more difficult as fuel burnup is extended. The reliability of the prediction of cold shutdown is sensitive to the ability to predcit the reactivity of local critical regions with steep neutron flux gradients. The reactivity of these regions is dependant on axial isotopic composition and burnup distributions. It therefore becomes essential to couple cold, simulated one stuck control rod measurements with extended burnup program measurements. Two localized cold critical measurements were performed at the Monticello reactor prior to Cycle 8 startup as part of a joint Department of Energy, General Electric Company, Northern States Power company extended fuel burnup program. The experiment provided a comparison to calculations made by the 3-D core simulator computer code for localized criticals. Both the experiment and the calculations closely represented the one struck rod condition in a high and low burnup region of the core.

29540 **(DOE/ET/34215—32) Fuel-Performance-Improvement Program. Semiannual progress report, April-September 1982.** Woods, K.N.; Barner, J.O. (Exxon Nuclear Co., Inc., Richland, WA (USA); Pacific Northwest Lab., Richland, WA (USA)). Mar 1983. Contract AC06-76RL01830;AC02-76ET34215. 39p. (PNL—4648). NTIS (US Sales Only), PC A03/MF A01. Order Number DE83010178.

Progress under the Fuel Performance Improvement Program (FPIP) is reported for the semiannual period of April-September 1982. The objectives of the FPIP are to develop commercially viable LWR fuel designs which are highly resistant to pellet-cladding interaction (PCI) failures and to demonstrate the satisfactory irradiation performance of the selected designs. During this period, documentation of irradiation tests carried out in the Halden Boiling Water Reactor (HBWR) was completed. Topical reports were issued covering the final steady-state irradiation tests, the ramping tests, and the post-irradiation examination of the irradiated fuel. The key observations and conclusions from these topical reports are summarized in this semiannual report. The major activity during this reporting period was the first series of segmented rod ramping tests conducted at the Studsvik R-2 reactor in Sweden.

29541 **(EPRI-NP—2879-SR) Plant Materials Program: progress June 1981 to May 1982.** Childs, W.; Cubicciotti, D.; Fox, M.; Giannuzzi, A.; Gilman, J.; Jones, R. (Electric Power Research Inst., Palo Alto, CA (USA)). Feb 1983. 263p. NTIS, PC A12/MF A01. Order Number DE83901964.

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This is the second annual progress report of the Plant Materials Subprogram, which was organized in May 1980 to address corrosion-related materials problems in light water reactors. The first section of the report provides an overview of plant materials problems which have a high impact on plant availability. These include pipe and pressure vessel cracking, condenser leakage, turbine disc cracking, steam geerator tube attack and cracking, and cracking of nickel alloy springs, beams and pins. The status and goals of research and development work related to each of these problems are reviewed briefly. Subsequent report sections provide more detailed reviews of significant progress in the relevant technical topic areas: intergranular stress corrosion cracking of austenitic stainless steels; environmentally-assisted cracking of carbon and low alloy steels; intergranular stress corrosion cracking of nickel-base alloys; and improved fabrication technology.

29542 **(EPRI-NP—2902) Piping seismic test with energy-absorbing devices. Final report.** Schneider, S.; Lee, H.M.; Godden, W.G. (California Univ., Berkeley (USA). Coll. of Engineering). Mar 1983. 175p. NTIS, PC A08/MF A01. Order Number DE83901985.

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This report presents the results of an investigation into the behavior of a complex spatial piping system under simulated seismic and thermal loading. The control of seismic response by steel energy absorbing devices is studied and compared with equivalent response controlled by shock arrestors. The concept is based on previous work on booth plane and spatial piping systems. The specimen selected for study was a half-scale model of a piping system from a nuclear reactor power plant. This was tested in its original design configuration using mechanical shock arrestors (snubbers), and subsequently in a revised configuration using ductile steel energy absorbers. The influence of the snubbers and of different energy absorbers on the dynamic response of the pipe system is discussed in this report. A direct one-to-one replacement of the snubbers by energy absorbers allows a direct comparison of the results.

29543 **(EPRI-NP—2914) SPEAR-BETA fuel-performance code system. COSTF: cost implications analysis post-processor. Final report.** Christensen, R. (Entropy Ltd., Lincoln, MA (USA)). Mar 1983. 175p. NTIS, PC A08/MF A01. Order Number DE83901971.

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The SPEAR-BETA fuel performance code system computes fuel reliability as a function of fuel precharacterization and operating history. This report describes an application of the SPEAR-BETA post-processor, COSTF, to the analysis of fuel failure cost implications for Oyster Creek Cycle 8. COSTF is a model which analyzes the cost implications of fuel failure and failure avoidance operations as a function of fuel precharacterization, operating history and cost parameters. The analysis reports baseline costs, representing those actually incurred during Cycle 8, and effects on these cost items of variations. Included are effects of varying 50 different cost parameters, as well as effects of varying power levels and ramp rates.

29544 **(EPRI-NP—2936-Vol.2) High-temperature filtration measurements at the Isar BWR plant. Volume 2. Final report.** Henzel, N.; Meier, M.; Greger, G.U. (Kraftwerk Union A.G., Erlangen (Germany, F.R.)). Mar 1983. 486p. NTIS, PC A21/MF A01. Order Number DE83901970.

This report details results of an analytical program used to assess the performance of an electromagnetic filter at the Isar Nuclear Power Station (KKI) in the Federal Republic of Germany. This installation is the first full-scale (6100 gpm) high-temperature filtration system operating at a nuclear power plant. Performance was characterized for the application of processing high-pressure drains at a BWR. Effects of magnetic field variations and startup/shutdown transients also were tested. Characteristics of the corrosion products were investigated, e.g., particle size, species, isotopic and chemical composition. The study shows that with proper operating conditions and careful selection of the point of application reasonable crud removal efficiencies can be achieved.

29545 **(EPRI-NP—2940) Licensing applications and requirements of an ideal steady-state fuel-performance code. Final report.** Fiero, I.B. (Combustion Engineering, Inc., Windsor, CT (USA)). Mar 1983. 34p. NTIS, PC A03/MF A01. Order Number DE83901956.

Licensing applications and requirements for an ideal steady-state fuel performance code are identified and characterized. Fifteen licensing applications are examined with respect to specific requirements as set forth in the Code of Federal Regulations, Nuclear Regulatory Guidelines and NRC Standard Review Plans. Code input data needs and output data requirements for each application and models necessary to represent the pertinent fuel behavioral phenomena are identified. Finally, an acceptable level of conservatism for each licensing application is established and guidelines for overall code accuracy are established. Overall code accuracy is discussed with respect to fuel temperature, fission gas release and internal rod pressure calculations.

29546 **(EPRI-NP—2941) SPEAR-FCODE-GAMMA functional specifications. Final report.** Fiero, I.B. (Combustion Engineering, Inc., Windsor, CT (USA)). Mar 1983. 38p. NTIS, PC A03/MF A01. Order Number DE83901951.

SPEAR FCODE GAMMA (SFG), a conceptual fuel-performance code for use in licensing analyses, has been defined and characterized as a set of functional specifications. The potential licensing-related applications of SFG are established and discussed. General code specifications including regulatory, interface, hardware application, code model and software, and operational specifications are discussed. The code input and output information including data requirements as well as formatting aspects are detailed. Finally, the SFG code-accuracy guidelines are established and the validation process is described.

29547 **(EPRI-NP—2960) Study of dilute reagent decontamination for application in boiling-water reactors.** Johnson, A.B. Jr.; Griggs, B.; Dillon, R.L.; Kustas, F.; Peters, R. (Battelle Pacific Northwest Labs., Richland, WA (USA)). Mar 1983. Contract AC06-76RL01830. 181p. NTIS (US Sales Only), PC A09/MF A01. Order Number DE83011032.

Decontamination of boiling water reactor (BWR) coolant systems is a potential future need. Battelle, Pacific Northwest Laboratories has conducted an experimental program to investigate the application of the dilute chemical decontamination (DCD) method to BWR coolant systems. Sections from radioactive BWR recirculation bypass piping were decontaminated in a once-through test facility (OTTF) from 60 to 180°C and in stirred beakers at 90°C. Several chelating agents with and without organic acids dissolved 80 to 90% of the radioactivity in a few hours. Several decontamination parameters were investigated in the OTTF, including reagent composition, temperature, concentration, pH, and oxidation-reduction characteristics. Reagent characteristics under recirculating conditions were investigated in isothermal loops. The radioactive crud/oxide (croxide) layers were characterized before and after the decontaminations.

29548 **(EPRI-NP—2964) Weld residual-stress redistribution near growing cracks. Final report.** Quinones, D.F.; Reaugh, J.E. (Science Applications, Inc., San Leandro, CA (USA); Science Applications, Inc., Albuquerque, NM (USA)). Mar 1983. 73p. NTIS, PC A04/MF A01. Order Number DE83901986.

A numerical analysis representing Intergranular Stress Corrosion Cracking (IGSCC) in a residual-stress field of the heat-affected zone (HAZ) of a girth-butt weld is presented. A complete, preexisting circumferential crack, growing radially outward in a 10-cm (4-in.) schedule 80 recirculation line, is modeled using the elastic properties of boiling water reactor (BWR) Type 304 stainless steel. An equilibrium solution for an uncracked pipe's residual stress field is applied as an initial condition; subsequent stresses are calculated incrementally, as the crack slowly propagates through the isothermal pipe wall. Results from these elastic calculations show that the axial extent of the initial residual stress field has little influence on the stress intensification and crack arrest for extents greater than three pipe wall thicknesses. Consequently, the current linear elastic fracture mechanics (LEFM) methods with residual stresses produce accurate stress intensity factors for the boundary conditions studied here.

29549 **(JAERI-M—9584) Light water reactor and polymeric materials.** Nakase, Y. (Japan Atomic Energy Research Inst., Tokyo). Jul 1981. 31p. (In Japanese). NTIS (US Sales Only), PC A03/MF A01. Order Number DE83701496.

SEAMATE-II(Simulated Environmental Apparatus for Material Testing-II) has been constructed in August, 1979 at Takasaki Radiation Chemistry Research Establishment, which is working quite well during one and half a year until now. Development of SEAMATE-II was planned at earlier period of 1976, and the apparatus was designed and built in the fiscal year of 1978. Meanwhile, SEAMATE-I was used to solve the problems for constructing SEAMATE-II. During the time the qualification test condition, guide or standard for electrical equipment used in nuclear power station has been investigated extensively from data published in and out of Japan. This report is a summary and an interpretation of qualification test conditions, testing methods, guides or standards for the electrical equipments used in light water reactors, and also data related to them. Items for the interpretation are selected from those of IEC(International Electrotechnical Commission) investigation.

29550 **(NUREG/CR—2044) Reactor operating experiences, 1978-1980.** Mays, G.T.; Winton, M.L. (comps.). (Oak Ridge National Lab., TN (USA)). Jan 1983. Contract W-7405-ENG-26. 193p. (ORNL/NSIC—194). NTIS, PC A09/MF A01 - GPO. Order Number DE83011039.

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This compilation contains those experiences reported during the period January 1978 through December 1980 in the NRC bulletin Power Reactor Events which superseded Current Events - Power Reactors in 1979. The individual reports were compiled by the Office of Management and Program Analysis with the Office for Analysis and Evaluation of Operational Data assuming this responsibility with the November to December 1980 report (Volume 3 Number 1). The reports for 1978 in Current Events - Power Reactors and for 1979 and 1980 in Power Reactor Events are presented in the order in which they appeared in the individual issues, with the issues arranged in chronological order. A reactor plant index and keyword index have been prepared using the NSIC thesaurus of indexing terms. In addition, a permuted-title index is included to assist the reader in locating reports of interest.

29551 **(NUREG/CR—2956) Neutron dosimetry at commercial nuclear plants. Final report of Subtask B: dosimeter response.** Cummings, F.M.; Endres, G.W.R.; Brackenbush, L.W. (Pacific Northwest Lab., Richland, WA (USA)). Mar 1983. Contract AC06-76RL01830. 113p. (PNL—4471). NTIS, PC A06/MF A01; - GPO $5.50. Order Number DE83010199.

As part of a larger program to evaluate personnel neutron dosimetry at commercial nuclear power plants, this study was designed to characterize neutron dosimeter responses inside the containment structure of commercial nuclear plants. In order to characterize those responses, dosimeters were irradiated inside containment at 2 pressurized water reactors and at pipe penetrations outside the biological shield at two boiling water reactors. The reactors were operating at full power during the irradiations. Measurements were also performed with electronic instruments, the tissue equivalent proportional counter (TEPC), and portable rem-meters, SNOOPY, RASCAL and PNR-4.

29552 **(NUREG/CR—2972) Analysis of density-wave oscillations in ventilated channels.** Taleyarkhan, R.; Podowski, M.; Lahey, R.T. Jr. (Rensselaer Polytechnic Inst., Troy, NY (USA). Dept. of Nuclear Engineering). Mar 1983. 546p. NTIS, PC A23/MF A01 - GPO. Order Number DE83901428.

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A mathematical model has been developed for the linear stability analyses of a system of ventilated parallel boiling channels. The model can accomodate phasic slip, arbitrary non-uniform axial power distributions, distributed local losses, heater wall dynamics, channel-to-channel radial power skews, discrete or continuous ventilation between the channels, turbulent mixing between the channels, various donor-cell options for the lateral transport of energy and momentum, and a transverse momentum equation, including storage and crossflow inertia. A special matrix reduction scheme was developed to efficiently solve the system of linearized, Laplace transformed , nodal equations. The digital computer programs, MAZDA-1F, MAZDA-4S and MAZDA-4F, were written for the numerical evaluation of the mathematical model developed.

29553 **(NUREG/CR—3220) Mechanistic aspects of stress-corrosion cracking of type 304 stainless steel in LWR systems.** Nichols, F.A. (Argonne National Lab., IL (USA)). Feb 1983. Contract W-31-109-ENG-38. 64p. (ANL—83-15). NTIS, PC A04/MF A01; - GPO. Order Number DE83010286.

A review is presented of mechanistic concepts pertaining to stress-corrosion cracking, especially centering on intergranular

stress-corrosion cracking of sensitized type 304 stainless steel in light water reactor environments. Based on this review several experiments are suggested for elucidating operative mechanisms and for obtaining important data under operating conditions. Suggestions are also given on the conduct and interpretation of laboratory experiments as well as examining alternative failure modes for proposed alternative alloys.

29554 **(SKI-B—13-80) Follow-up of transients. Stage 1.** Enekull, Aa.; Wallner, B. (Statens Kaernkraftinspektion, Stockholm (Sweden)). Sep 1981. 369p. (In Swedish). NTIS (US Sales Only), PC A16/MF A01. Order Number DE83701502.

A follow-up of the transients of temperature and pressure in the primary pressurized system of a nuclear power plant has been completed for the Barsebaeck-1 reactor. The investigation consists of the following steps:- the collation of transients - drawing up load data based on transients-analyses of stress - recommendations for future programs. It was found that the lifetime of the system will exceed 40 years excluding some of the pipes for feed water. The appendices give a detailed description of the transients.(G.B.).

29555 **(EPRI-NP—2291-CCM-Vol.2-Rev.1) SPEAR-BETA fuel-performance code system. Volume 2 (revision 1). Part 1. Programmer's manuals. Part 2. User's manual.** Duchane, E. (ed.). (Entropy Ltd., Lincoln, MA (USA)). Mar 1983. 177p. NTIS, PC A09/MF A01. Order Number DE83901905.

This report presents an overview of the BETA version of the SPEAR Code System, which is a set of computer software (programs, subprograms, subroutines, functions, and data files) for computing the performance of nuclear fuel rods during in-reactor operations.

29556 **Fluid forces acting on circular cylinders in liquid cross flow.** Jendrzejczyk, J.A.; Chen, S.S. (Argonne Natl Lab, IL, USA). *American Society of Mechanical Engineers, Pressure Vessels and Piping Division,* [*Technical Report*] *PVP;* 63: 31-44(1982). (CONF-820601—).

A force transducer which can be employed to measure both steady and fluctuating fluid force components is described. Force transducers are then applied to measure fluid force components for (1) a single circular cylinder; (2) two tubes in tandem; and (3) two tubes normal to flow. Experimental results are presented for Strouhal number, steady drag and lift forces, and fluctuating drag and lift forces. The effect of upstream turbulence is also investigated. 44 refs.

2102 Power Reactors, Non-breeding, Light-water Moderated, Non-boiling Water Cooled

REFER ALSO TO CITATION(S) 29117, 29143, 29204, 29206, 29537, 29540, 29541, 29542, 29545, 29546, 29549, 29550, 29551, 29553, 29555, 29596, 29597, 29599, 29600, 29624, 29625, 29634, 29635, 29637, 29639, 29640, 29641, 29642, 29643, 29644, 29645, 29646, 29647, 29649, 29651, 29652, 29653, 29654, 29655, 29656, 29657, 29658, 29659, 29660, 29667, 29668, 29671, 29672, 29673, 29674, 29678, 29680, 29683, 29684, 29685, 29688, 29689, 29690, 29694, 29697, 29698

29557 **(DOE/ET/34212—37) Qualification of the B and W Mark B fuel assembly for high burnup. Eighth semi-annual progress report, January-June 1982.** Coleman, T.A.; Dideon, C.G. (Babcock and Wilcox Co., Lynchburg, VA (USA)). Sep 1982. Contract AC02-78ET34212. 59p. (BAW—1546-8). NTIS (US Sales Only), PC A04/MF A01. Order Number DE83010395.

The extended-burnup performance of Babcock and Wilcox-designed Mark B (15 x 15) pressurized water reactor fuel is being evaluated through irradiations in Duke Power Company's Oconee Unit 1 reactor. This report, covering the period from January through June 1982, is the eighth semi-annual progress report for the program. During this period, assembly 1D45 continued its fifth cycle of irradiation in Oconee 1, cycle 7. It will achieve an assembly average burnup of more than 50,000 MW/mtU by the end of the cycle in late 1983. Efforts during this report period included completing the hot cell examinations of fuel rods extracted from a 31,000 MWd/mtU, three-cycle assembly and a 40,000 MWd/mtU, four-cycle assembly, and developing nondestructive eddy current oxide thickness measurement systems. Oxide thickness measurement systems for use in the hot cell and at the reactor site were designed and fabricated. The hot cell system is being tested and calibrated.

29558 **(EGG—2250) EPICOR II Research and Disposition Program: FY-1982 annual report.** Reno, H.W.; Dodge, R.L. (EG and G Idaho, Inc., Idaho Falls (USA)). Mar 1983. Contract AC07-76ID01570. 32p. NTIS, PC A03/MF A01. Order Number DE83010979.

The goal of the EPICOR II Research and Disposition Program is to safely dispose of EPICOR II liners as low-level radioactive waste. The FY-1982 Annual Report summarizes the progress toward achievement of that goal. The report describes the structural and mechanical changes to the Test Area North Hot Shop and its related facilities necessary for receipt and storage of the liners: design and construction or refurbishment of storage silos, storage casks, gas venting system, remote handling equipment, gas venting tools, and a transportation cask air sampler. It describes the receipt of two EPICOR II liners at INEL during FY-1982 (Prefilters 16 and 1) and the removal of the resin in Liner 16 as part of a liner integrity study. The report also summarizes the generation of the 50 EPICOR II liners, Three Mile Island-INEL Coordination, Waste Transportation, Waste Receipt and Storage, and the EPICOR II Research and Disposition Programs.

29559 **(EPRI-NP—2921) Steam-generator tube-plugging and tube-sleeving criteria: assessment of current practices.** Rau, S.A.; Derbalian, G.; Thomas, J.M. (Failure Analysis Associates, Palo Alto, CA (USA)). Mar 1983. 240p. NTIS, PC A11/MF A01. Order Number DE83901991.

A two-part project was undertaken to: (1) review steam-generator tube plugging/sleeving practices and (2) numerically and experimentally analyzed strain in dented tubes. A review of the open literature and a survey of the majority of Steam-Generator Owners-Group Utilities concerning steam-generator tube plugging and sleeving criteria was performed. The review concentrated on the evolution of a plant's plugging/sleeving criteria, technical bases of the criteria, and field experience using these criteria in preventing tube leaks. Strain in dented tubes was analyzed. A finite-element analysis was performed as a check on the Fourier series and cubic-spline strain-calculation techniques. Finite-element results were verified by an experimental program using a moire grid technique that measured tube outside diameter (OD) and inside diameter (ID) surface hoop strains in mechanicaly dented tubes. Strain results from the finite-element and experimental programs were then used to test the accuracy of the Fourier series and cubic-spline techniques.

29560 **(EPRI-NP—2922) Characterization of contaminants in TMI-2 systems.** Daniel, J.A.; McVey, T.L.; Schlomer, E.A.; Keefer, D.G. (Science Applications, Inc., Rockville, MD (USA). Nuclear Environmental Services Div.). Mar 1983. 309p. NTIS, PC A14/MF A01. Order Number DE83901942.

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This interim report contains sample and measurement data used to characterize the contamination of the TMI-2 Reactor Coolant system and connected systems. The report also describes physical orientation, materials of construction, physical locations within the plant, operational notes and a brief history of operation, and decontamination efforts for individual components. Schematic flow diagrams of systems and general arrangement diagrams are included to assist the user in interpreting the data.

29561 **(EPRI-NP—2957) Fatigue performance of Ni-Cr-Fe Alloy 600 under typical PWR steam-generator conditions. Final report.** Jacko, R.J. (Westinghouse Electric Corp., Pittsburgh, PA (USA). Research and Development Center). Mar 1983. 394p. NTIS, PC A17/MF A01. Order Number DE83901948.

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Results are presented of an experimental program to determine the fatigue performance of thin-wall alloy 600 tubing in various high temperature environments representative of reference and

faulted PWR steam generator conditions. The test matrix includes strain controlled, low-cycle fatigue; load controlled, high-cycle fatigue; and, resonant, ultrasonic fatigue tests in environments of air, AVT water, superheated steam, alkaline sulfate/silicate solutions, acid sulfate/silicate solutions with and without oxygen addition, and caustic/sulfate solutions. The majority of the tests were conducted over a temperature range from 290 to 316°C (552 to 600°F). Fatigue test results indicate that no environmental decrease in fatigue behavior occurs in a reference environment of AVT water and superheated steam. However, a significant reduction in fatigue strength was observed in acid sulfate/silicate environments.

29562 **(EPRI-NP—2963) Investigation of phosphate-sludge interactions. Final report.** Connor, W.M.; Panson, A.J. (Westinghouse Electric Corp., Pittsburgh, PA (USA). Research and Development Center). Mar 1983. 91p. NTIS, PC A05/MF A01. Order Number DE83901982.

The reaction of sodium phosphate solution with artificial steam-generator sludge has been investigated under static exposure conditions at 150°F. Residual phosphates, remaining after a series of drain-fill-soak operations, react at 350°F. The rate of reaction increases at 550°F. Data collected at 600°F show that 0.1 M phosphate solutions with sodium-to-phosphate molar ratios of 2.0 and 2.8 react with both magnetite and sludge to increase solution alkalinity and to produce solids which dissolve noncongruently. X-ray-diffraction data show that the same brick-red sodium-iron-phosphate solid-reaction product is formed when 2.8 ratio phosphate reacts with either magnetite or magnetite-containing sludge.

29563 **(EPRI-NP—2968) Primary-side deposits on PWR steam-generator tubes.** Bergmann, C.A.; Roesmer, J.; Perone, D.W. (Westinghouse Electric Corp., Pittsburgh, PA (USA)). Mar 1983. 70p. NTIS, PC A04/MF A01. Order Number DE83901952.

The evaluation of analyses of material removed from primary side steam generator tubing samples taken from nuclear plants that had operated for up to 7 effective full power years are presented in this report. The types of analyses incuded radiochemical, chemical, scanning electron microscope (SEM), and energy dispersive x-ray (EDAX) techniques to characterize the surfaces and composition of the tubing material. An evaluation of the data obtained and a comparison with in-core crud data and with values calculated by a mathematical activity transport model (CORA) are also given in the report.

29564 **(EPRI-NP—2979) Diffusion and hideout in crevices. Final report.** Cleary, J.G.; Von Nieda, G.E.; Lindsay, W.T. Jr. (Westinghouse Electric Corp., Pittsburgh, PA (USA). Research and Development Center). Mar 1983. 187p. NTIS, PC A09/MF A01. Order Number DE83901953.

The EPRI Steam Generator Project Office sponsored this investigation to identify and formulate the important variables that control contaminant hideout in and return from severely dented support plate crevices in steam generators. The project objectives were to determine the diffusion rates of ionic species through porous magnetite and to determine the effect of heat flux on their hideout in packed crevices. Results of investigations in four specific areas are presented: (1) a literature review and estimation of diffusion coefficients for electrolytes in hot water; (2) an experimental study of diffusion rates through simulated crevice packing; (3) a study of contaminant hideout rates as a function of applied heat flux; and (4) the development of a mathematical model to evaluate concentration and mass transfer of soluble corrodants from bulk water to and from steam-generator crevices.

29565 **(NUREG/CR—2524) Evaluation of personnel neutron dosimetry at operating nuclear power plants.** Ryan, R.M. (Rensselaer Polytechnic Inst., Troy, NY (USA). Dept. of Nuclear Engineering). Mar 1983. 84p. NTIS, PC A05/MF A01 - GPO $5.00. Order Number DE83901632.

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The basic objective of this research program titled Evaluation of Personnel Neutron Dosimetry at Operating Nuclear Power Plants, sponsored by the United States Nuclear Regulatory Commission, was to evaluate neutron personnel monitoring devices and/or methods used at nuclear power plants. To accomplish this research, measurements were made in areas where personnel are likely to have access during reactor operation. Measurements were made of spectral and flux distribution of neutrons. Dose equivalent surveys were made of neutrons and gammas in operating areas with portable survey meters. Gamma to neutron ratios were obtained. A new computer code, BONABS was developed to incorporate the response of portable neutron survey meters with an existing code BONNER used for neutron spectrum unfolding techniques.

29566 **(WAPD-MRP—159) Shippingport Atomic Power Station. Technical progress report, July 26, 1982-January 25, 1983.** (Bettis Atomic Power Lab., West Mifflin, PA (USA)). 1983. Contract AC11-76PN00014. 38p. NTIS, PC A03/MF A01. Order Number DE83011214.

The Shippingport Atomic Power Station was operated with the Light Water Breeder Reactor (LWBR) core primarily at maximum allowable core power levels (base load) until October 1, 1982, when power operations were terminated. The LWBR core had achieved 28,730 EFPH. Several brief reductions in power for testing and maintenance occurred during this period. The end-of-life test program began October 1, 1982, and was completed 30, 1982. Preparation of the plant for defueling was completed and defueling was started on December 7, 1982. The core is being removed so that the spent fuel can be shipped to the Naval Reactors Expended Core Facility for a detailed examination to verify core performance including an evaluation of breeding characteristics.

29567 **Effects of temperature and pressure on the in-reactor creepdown of Zircaloy fuel cladding.** Hobson, D.O.; Thoms, K.R.; Dodd, C.V.; van der Kaa, Th. (Oak Ridge Natl Lab, TN, USA). *American Society for Testing and Materials, Special Technical Publication;* 173-192(1982). (CONF-800834—).

From 5. international conference on zirconium in the nuclear industry; Boston, MA, USA (4 Aug 1980).

Tests were conducted to study the behavior of Zircaloy fuel cladding under conditions that approximate those found in an operating pressurized-water power reactor. Radial surface displacement values as functions of time, average diametral-circumferential strain as a function of time, and isochronal deformation surfaces are presented. Tests were conducted at 343 degree C with external pressures from 13.3 to 18.7 MPa. Contrary to similar tests conducted out-of-reactor, the in-reactor specimens did not deform uniformly, that is, by diametral contraction and smooth ovalization. Rather, the deformation surfaces were nonuniform with hills and valleys being formed at irregular intervals. This implies that conventional concepts of creep rate and simplified modeling procedures will not work for predicting cladding behavior. 10 refs.

29568 **Comparison of the high-temperature oxidation behavior of Zircaloy-4 and pure zirconium.** Pawel, R.E.; Campbell, J.J. (Oak Ridge Natl Lab, TN, USA). *American Society for Testing and Materials, Special Technical Publication;* 370-389(1982). (CONF-800834—).

From 5. international conference on zirconium in the nuclear industry; Boston, MA, USA (4 Aug 1980).

Steam oxidation of pure, arc-melted, crystal-bar zirconium was studied under isothermal conditions in the temperature range 1000 to 1500 degree C. The results were compared with available oxidation rate data for zircaloy-4 in order to examine the influence of minor alloying additions on the parameters critical to the oxidation behavior. While the basic oxidation processes for zirconium and Zircaloy-4 are identical, significant differences in the kinetics, oxygen diffusivities, and morphology were observed. Thus, in addition to the decreased oxygen diffusivity in the oxide phase on pure zirconium compared with that on Zircaloy-4, a higher activation energy was observerd, implying that some mechanistic differences exist. Significant morphological and grain size differences in the columnar oxide growing suggest that the relative contributions to oxide growth from short-circuit diffusion differ in the two oxides. 27 refs.

2103 Power Reactors, Non-breeding, Graphite Moderated

REFER ALSO TO CITATION(S) 29205, 29537, 29595, 29601, 29602, 29603, 29604, 29605, 29606, 29607, 29683, 29684, 29953

29569 (CONF-830301—14) Integrated Compartment Method appication to the transient heat transfer in gas-cooled reactor. Chen, N.C.J.; Yeh, G.T. (Oak Ridge National Lab., TN (USA)). 1983. Contract W-7405-ENG-26. 18p. NTIS, PC A02/MF A01. Order Number DE83010144.

From ASME-JSME thermal engineering joint conference; Honolulu, HI, USA (20 Mar 1983).

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Integrated Compartment Method (ICM), an effective numerical integration algorithm, was developed to solve the transient heat conduction coupled with convection. Application of the ICM to the mathematical model simulating a graphite test structure heated in an annular flow stream of hot helium has been successfully demonstrated. However, the model validation can not be performed until experimental data become available.

29570 (GA-A—15999) Peach Bottom test element program. Final report. Saurwein, J.J.; Holzgraf, J.F.; MIller, C.M.; Myers, B.F.; Wallroth, C.F. (GA Technologies, Inc., San Diego, CA (USA)). Nov 1982. Contract AT03-76ET35300. 312p. NTIS, PC A14/MF A01. Order Number DE83009706.

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Thirty-three test elements were irradiated in the Peach Bottom high-temperature gas-cooled reactor (HTGR) as part of the testing program for advanced HTGRs. Extensive postirradiation examinations and evaluations of 21 of these irradiation experiments were performed. The test element irradiations were simulated using HTGR design codes and data. Calculated fuel burnups, power profiles, fast neutron fluences, and temperatures were verified via destructive burnup measurements, gamma scanning, and in-pile thermocouple readings corrected for decalibration effects. Analytical techniques were developed to improve the quality of temperature predictions through feedback of nuclear measurements into thermal calculations. Dimensional measurements, pressure burst tests, diametral compression tests, ring-cutting tests, strip-cutting tests, and four-point bend tests were performed to measure residual stress, strain, and strength distributions in H-327 graphite structures irradiated in the test elements.

29571 (GA-A—16927) HTGR Plant Technology Program. Semiannual report for the period ending September 24, 1982. (GA Technologies, Inc., San Diego, CA (USA)). Nov 1982. Contract AT03-76ET35301. 258p. NTIS, PC A12/MF A01. Order Number DE83009011.

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This document reports the technical accomplishments on the HTGR Plant Technology Program at GA Technologies Inc. (formerly General Atomic Company) during the second half of FY-82. It covers a period when the design direction of the National HTGR Program is to support a steam cycle cogeneration plant with a lesser but continuing emphasis on higher-temperature applications. Information is presented concerning program management; materials; plat technology; component design verification and support; and technolog transfer.

29572 (GA-A—16962) Evaluation of Toshiba Type HS-2 fission chamber. Franklin, R.N. (GA Technologies, Inc., San Diego, CA (USA)). Jan 1983. Contract AT03-76ET35301. 114p. NTIS, PC A06/MF A01. Order Number DE83009695.

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A sensor was sought for the in-core flux mapping unit of the large high-temperature gas-cooled reactor. The in-core environment is very harsh, with temperatures up to 800°C and a neutron flux of 1 x 10^{14} nv. Self-powered neutron detectors and a small fission chamber had been tested previously. The fission chamber (Toshiba FS-3) showed promise, and the manufacture and testing of a large unit was suggested. This report presents the data and conclusions of a test performed on the Toshiba HS-2 fission chamber. This larger sensor performed well in the harsh test environment. The study found that this sensor is able to provide data accurate to +- 6% and can last for 50 h total at 800°C. Exposure of a sensor to an actual core environment, such as in the Fort St. Vrain reactor, was recommended.

29573 (ORNL/TM—8583) Integrated compartment method application to the transient heat transfer in gas-cooled reactor. Chen, N.C.J.; Yeh, G.T. (Oak Ridge National Lab., TN (USA)). Apr 1983. Contract W-7405-ENG-26. 25p. NTIS, PC A02/MF A01. Order Number DE83010448.

Integrated Compartment Method (ICM), an effective numerical integration algorithm, was developed to solve the transient heat conduction coupled with convection. Application of the ICM to the mathematical model simulating a graphite test structure heated in an annular flow stream of hot helium has been successfully demonstrated. However, the model validation can not be performed until experimental data become available.

2104 Power Reactors, Non-breeding, Otherwise Moderated Or Unmoderated

REFER ALSO TO CITATION(S) 29537, 29600, 29937, 29938

2105 Power Reactors, Breeding

REFER ALSO TO CITATION(S) 29112, 29537, 29566, 29618, 29626, 29627, 29628, 29629, 29630, 29631, 29632, 29633, 29636, 29684, 29687, 29688, 29691, 29699, 30741, 30742, 30743, 30746, 30754, 30758, 30768, 30770, 30774

29574 (ANL—83-1) DIF3D nodal neutronics option for two- and three-dimensional diffusion theory calculations in hexagonal geometry. Lawrence, R.D. (Argonne National Lab., IL (USA)). Mar 1983. Contract W-31-109-ENG-38. 170p. NTIS, PC A08/MF A01. Order Number DE83011019.

A nodal method is developed for the solution of the neutron-diffusion equation in two- and three-dimensional hexagonal geometries. The nodal scheme has been incorporated as an option in the finite-difference diffusion-theory code DIF3D, and is intended for use in the analysis of current LMFBR designs. The nodal equations are derived using higher-order polynomial approximations to the spatial dependence of the flux within the hexagonal-z node. The final equations, which are cast in the form of inhomogeneous response-matrix equations for each energy group, involved spatial moments of the node-interior flux distribution plus surface-averaged partial currents across the faces of the node. These equations are solved using a conventional fission-source iteration accelerated by coarse-mesh rebalance and asymptotic source extrapolation. This report describes the mathematical development and numerical solution of the nodal equations, as well as the use of the nodal option and details concerning its programming structure. This latter information is intended to supplement the information provided in the separate documentation of the DIF3D code.

29575 (ANL—83-4, pp 1-17) Neutron capture data and FBR performance predictions. Collins, P.J. (Argonne National Lab., Idaho Falls, ID). 1982. NTIS, PC A99/MF A01.

From NEANDC/NEACRP specialists meeting on fast-neutron capture cross sections; Argonne, IL, USA (20 Apr 1982).

The accuracy requirements for Physics parameters in fast breeder reactors and the extent to which they are achieved through tests with integral experiments are reviewed. Sensitivities to capture cross sections are discussed for calculations of fuel enrichment, breeding ratio, reactivity, safety parameters, power distributions,and control rod worths.

29576 **(CEA-CONF—6138) Particular characteristics of fast reactors: functional aspects and technological aspects.** Cazalet, M.; Marbach, M.; Debru, M.; Decuyper, M. (CEA Centre d'Etudes Nucleaires de Cadarache, 13 - Saint-Paul-les-Durance (France)). Dec 1981. 13p. (In French). (CONF-811264—2). NTIS (US Sales Only), PC A02/MF A01. Order Number DE83700385.

From SFEN meeting on power station control to meet the electric network requirements; Paris, France (8 Dec 1981).

From the overall studies it is possible favourably to envisage the operation of fast reactors with respect to the requirements of the network. The thermal stresses of the structures and of the fuel resulting from keeping up with network demand are, in point of fact, limited in amplitude and variation speed owing to the significant masses of sodium around the core in particular. The spatial deformations of the neutron flux do not present the difficulties found in thermal reactors, nor is there any problem linked to xenon poisoning. The uncertainties remaining on the long term effects of network follow-up operation, do, however, require research and development in greater depth on the fuel elements in particular once they have reached a high irradiation rate.

29577 **(CEA-CONF—6144) Measurements of the Doppler effect at Phenix.** Gauthier, J.C.; Vanier, M.; Cabrillat, J.C. (CEA Centre d'Etudes Nucleaires de Cadarache, 13 - Saint-Paul-les-Durance (France)). Sep 1981. 14p. (CONF-810975—5). NTIS (US Sales Only), PC A02/MF A01. Order Number DE83700386.

From Meeting of the Nuclear Energy Agency Committee on reactor physics; Winfrith, Dorset, UK (14 Sep 1981).

A measurement of the Doppler effect has been performed at Phenix. Large corrections were necessary. Thus the measurement has been done again on another way. Results agree. A comparison has been made with the results of a theoretical calculation performed with the CARNAVAL IV "formulaire".

29578 **(CEA-CONF—6156) Impact of core design on the fuel cycle of fast neutron reactors.** Cabrillat, J.C.; Clauzon, P.; Dufour, P. (CEA Centre d'Etudes Nucleaires de Cadarache, 13 - Saint-Paul-les-Durance (France)). Nov 1981. 11p. (In French). (CONF-811154—4). NTIS (US Sales Only), PC A02/MF A01. Order Number DE83700388.

From International conference on fast reactor fuel cycles; London, UK (9 Nov 1981).

The value of the annual flow of fissile mixed oxide passing through the plants of the fabrication-reprocessing cycle has a preponderant effect on the cost of the fuel cycle of fast reactors. This annual flow can be reduced either by increasing the performance of the fuel elements or by using new core concepts. It is this latter possibility that is examined in this paper using a steel atom displacement criterion as criterion for the end of life of fuel assemblies. The facts provided should make it possible to guide the choice of core concept of the reactors built after Super Phenix in order to improve on the cost of the fuel cycle of fast reactors.

29579 **(CEA-CONF—6179) Contribution to perfecting eddy current testing of steam generator tubes of sodium cooled breeders: description of the Monacault loop for the study of sodium deposit influence.** Lapicore, A.; Lemarquis, J.C.; Oberlin, C.; Pigeon, M. (CEA Centre d'Etudes Nucleaires de Cadarache, 13 - Saint-Paul-les-Durance (France)). Dec 1981. 14p. (In French). (CONF-8111124—1). NTIS (US Sales Only), PC A02/MF A01. Order Number DE83700389.

From Topical meeting LMFBR steam generators; Genoa, Italy (30 Nov 1981).

In the event of sodium-water reaction in the steam generator of a sodium cooled breeder reactor, it is essential to be able to monitor the local loss of thickness of the tubes located in the reaction area. A method for monitoring the tubes by an eddy current probe is being developed for Super Phenix. The sodium deposits on the outer wall of the tubes, as well as their prolonged contact with high temperature sodium are likely to bring about a change in the signals picked up. A test loop, Monacault, has been built in order to clarify the importance of these parameters (effect of sodium deposits, reproducibility of the wetting at different temperatures). It includes three test cells containing the sample tubes having a total of 61 standard defects to be tested. The first results on the wetting of tubes are given and discussed.

29580 **(CEA-CONF—6189) Cavitation characterization by the acoustic method. Application to a pump model and to the primary pump of the Super Phenix fast reactor.** Courbiere, P.; Defaucheux, J.; Panni, S. (CEA Centre d'Etudes Nucleaires de Cadarache, 13 - Saint-Paul-les-Durance (France)). Dec 1981. 18p. (In French). (CONF-811266—1). NTIS (US Sales Only), PC A02/MF A01. Order Number DE83700390.

From Symposium on hydraulics and noise S.H.F.; Paris, France (15 Dec 1981).

In order to study the pumps of fast reactors, water tests were first carried out on a model and then on the primary pumps of Super Phenix. The aim of these tests is to define cavitation acoustic criteria. The results obtained show that noise in a pump varies with the drop in characteristics and can therefore represent a state of cavitation.

29581 **(CONF-820704—47) Method for reliability analysis of complex reactor systems.** Elerath, J.G.; Vaurio, J.K.; Wood, A.P. (General Electric Co., Sunnyvale, CA (USA). Advanced Reactor Systems Dept.; Argonne National Lab., IL (USA); Stanford Univ., CA (USA). Dept. of Operations Research). 1982. Contract W-31-109-ENG-38. 13p. NTIS, PC A02/MF A01. Order Number DE83009027.

From International topical meeting on LMFBR safety; Lyon, France (18 Jul 1982).

Portions are illegible in microfiche products.

A method and a computer code for efficient and accurate reliability analyses of complex reactor systems are described and illustrated through an example. The method permits realistic analyses through its ability to accurately model and evaluate instantaneous and average unavailabilities for large systems with dependencies. The component models can include continuously monitored, non-repairable, and periodically tested components which are subject to failures resulting from components which are subject to failures resulting from component demands, stand-by conditions, human errors associated with testing and repair, as well as failures during actual operation. The numerical process used is efficient and allows analysis of general system configurations with arbitrary scheduling of maintenance operations.

29582 **(CONF-830538—1) Analysis of grid-assembly shielding of EBR-II.** Meneghetti, D.; Franklin, F.C.; Kucera, D.A. (Argonne National Lab., IL (USA)). 1983. Contract W-31-109-ENG-38. 10p. NTIS, PC A02/MF A01. Order Number DE83010799.

From 6. international conference on radiation shielding; Tokyo, Japan (16 May 1983).

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Differing neutron exposure rates to the EBR-II lower grid plenum assembly resulting from the historical changes in reactor configuration and shielding are analyzed to obtain the fluences and the steel displacements-per-atom values in this irreplaceable component.

29583 **(CONF-8104129—2) Finite-element treatment of concrete cracking and thermal structural analysis.** Marchertas, A.H. (Argonne National Lab., IL (USA)). 1981. Contract W-31-109-ENG-38. 29p. NTIS, PC A03/MF A01. Order Number DE83009010.

From Workshop on constitutive relations for concrete; Albuquerque, NM, USA (28 Apr 1981).

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The objective of this presentation is to describe the work on analytical modeling of concrete behavior at the Argonne National Laboratory (ANL) stressing in particular the approaches that are found to be most promising.

29584 **(CONF-8106230—3) Dynamic behavior of homogeneous and heterogeneous LMFBR core-design concepts.** Chang, Y.I.; Henryson, H. II; Orechwa, Y.; Su, S.F.; Greenman, G.; Blomquist, R. (Argonne National Lab., IL (USA)). 1981. Contract W-31-109-ENG-38. 41p. NTIS, PC A03/MF A01. Order Number DE83010718.

From Conference on core design features affecting dynamic behaviour; Rome, Italy (2 Jun 1981).

The emphasis is placed on obtaining an understanding of the inherent difference between homogeneous and heterogeneous core configurations regarding neutronic characteristics related to the dynamic behavior. The space-time neutronic and thermal-hydraulic behavior was analyzed in detail for various core configurations by using the FX2-TH, a two-dimensional kinetics code with thermal-hydraulic feedback. In addition, the relationship between the flux tilt and the fundamental-to-first harmonic eigenvalue separation, and the sodium void reactivity in heterogeneous cores were also studied.

29585 **(DOE/ER/12075—1PR) Hydrodynamic prediction of multidimensional single- and two-phase flow in rod arrays. Progress report, May 15-December 31, 1982.** Ebeling-Koning, D.B.; Robinson, J.T.; Todreas, N.E. (Massachusetts Inst. of Tech., Cambridge (USA)). Jan 1983. Contract AC02-82ER12075. 122p. NTIS, PC A06/MF A01. Order Number DE83005316.

The objective of this research is to develop comprehensive constitutive models for the hydrodynamics of flows at oblique angles in rod arrays, and determine their impact on design and performance analysis of heat exchanging components. The constitutive parameters are for single-phase flow the solid-fluid flow resistance, and for two-phase flow the phase flow resistances and relative phase motion. This report covers accomplishments of three tasks: (1) superposition models, data, and correlations for multi-dimensional, single-phase flow resistance are reviewed and compared; (2) two-phase flow observations and an individual bubble trajectory model for oblique flows are presented; and (3) single-phase flow analyses of several baffled heat exchangers were performed to determine the sensitivity of calculated pressure and flow fields to the choice of superposition model.

29586 **(DOE/ET/37230—T1) Reactor theory and analysis. Final report, June 1, 1974-December 31, 1982.** (Rensselaer Polytechnic Inst., Troy, NY (USA)). 1982. Contract AC02-76ET37230. 5p. NTIS, PC A02/MF A01. Order Number DE83009038.

The application of modal analysis to fast reactor problems is discussed. This research applies to fast reactor problems a type of technique that has been found to be of considerable use in reducing the cost of analyzing multidimensional power distributions in light water reactors. In the course of the investigation, a new modal option was developed that was found to be particularly effective in fast reactor problems. A test program in hexagonal geometry was developed. This test program was applied to a variety of fast reactor test problems analogous to those considered in rectangular geometry testing.

29587 **(JAERI-M—9638) Applicability of three dimensional diffusion theory programmes based on coarse mesh methods to calculating nuclear characteristics of fast breeder reactors.** Hotta, M.; Iijima, S.; Yoshida, H. (Japan Atomic Energy Research Inst., Tokyo). Aug 1981. 79p. (In Japanese). NTIS (US Sales Only), PC A05/MF A01. Order Number DE83701523.

Hexagonal coarse mesh methods in three dimensional diffusion theory programme have been examined for calculating in detail nuclear characteristics of fast breeder reactors composed of hexagonal fuel assemblies, comparing with more accurate triangular fine mesh method. The fast breeder reactors considered here are LMFBRs with different core configurations including heterogeneous core and GCFRs in different burnup states. The nuclear characteristics investigated in the comparative study are effective multiplication factor, power and neutron flux distributions, breeding ratio, reactivity effects and control rod reactivity worth. The comparative study indicates that the conventional coarse mesh method is not adequate to detailed evaluation on nuclear characteristics of fast breeder reactors, and that the improved coarse mesh method developed by T. Takeda et al. is very useful for this purpose, though some problems exists in evaluation of power distribution and breeding ratio of the extremely composite fast breeder reactors, such as the radially heterogeneous core LMFBR.

29588 **(NIIAR—12(465)) Some problems of the fast reactor fuel cycle.** Tsykanov, V.A.; Dem'yanovich, M.A.; Skiba, O.V.; Nikol'skij, R.V.; Serov, A.V.; Porodnov, P.T.; Gadzhiev, G.I. (Nauchno-Issledovatel'skij Inst. Atomnykh Reaktorov, Dimitrovgrad (USSR)). 1981. 10p. (In Russian). NTIS (US Sales Only), PC A02/MF A01. Order Number DE83700391.

Discussed are some problems and practical features of fast reactor closed fuel cycle as well as the main results from investigations and developments of the BOR-60 mixed vibrocompacted uranium-plutonium fuel element fabrication technology and tests, from studies of fuel reprocessing and granulation processes, and from the experimental analysis of the reactor fuel breeding factor. The information is presented about the establishment of technical base for testing individual stages of the fast reactor fuel cycle.

29589 **Passive heat-transfer means for nuclear reactors.** Burelbach, J.P. US Patent Application 6-387,113. 10 Jun 1982. 23p.

An improved passive cooling arrangement is disclosed for maintaining adjacent or related components of a nuclear reactor within specified temperature differences. Specifically, heat pipes are operatively interposed between the components, with the vaporizing section of the heat pipe proximate the hot component operable to cool it and the primary condensing section of the heat pipe proximate the other and cooler component operable to heat it. Each heat pipe further has a secondary condensing section that is located outwardly beyond the reactor confinement and in a secondary heat sink, such as air ambient the containment, that is cooler than the other reactor component. By having many such heat pipes, an emergency passive cooling system is defined that is operative without electrical power.

29590 **Spring bypass assembly.** Jablonski, H.; Roughgarden, J.D. US Patent Application 6-384,306. 2 Jun 1982. 10p.

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Pipe clamp comprises two substantially semicircular rim halves biased toward each other by spring assemblies. Adjustable stop means 5 limit separation of the rim halves when the pipe expands.

29591 **Vibrating fuel grapple.** Chertock, A.J.; Fox, J.N.; Weissinger, R.B. (to Dept. of Energy). US Patent 4,332,640. 1 Jun 1982. Filed date 30 Apr 1979. vp.

PAT-APPL-034229.

A reactor refueling method utilizing a vibrating fuel grapple for removing spent fuel assemblies from a reactor core which incorporates a pneumatic vibrator in the grapple head, enabling additional withdrawal capability without exceeding the allowable axial force limit. The only moving part in the vibrator is a steel ball, pneumatically driven by a gas, such as argon, around a track, with centrifugal force created by the ball being transmitted through the grapple to the assembly handling socket.

29592 **Effect of elbow translations on pressure transient analysis of piping systems.** Otwell, R.S. (Mich State Univ, East Lansing, USA). *American Society of Mechanical Engineers, Pressure Vessels and Piping Division,* [*Technical Report*] *PVP;* **64**: 127-136(1982). (CONF-820601—).

An analysis procedure is presented designed to incorporate pipe translations into a detailed fluid analysis of a transient event in a piping system. Flexible pipe reaches are represented as single degree of freedom structures whose movement is incorporated into the fluid solution through continuity relationships at pipe elbows. The driving force for the pipe reaches are the unbalanced fluid pressure forces acting on the elbows. The analysis method is outlined, and a representative piping system is studied. 6 refs.

2106 Power Reactors, Auxiliary, Mobile, Package, And Transportable

29593 **(ESG-DOE—13399) Space reactor electric systems: system integration studies, Phase 1 report.** Anderson, R.V.; Bost, D.; Determan, W.R.; Harty, R.B.; Katz, B.; Keshishian, V.; Lillie, A.F.; Thomson, W.B. (Rockwell International Corp., Canoga Park, CA (USA). Energy Systems Group). 29 Mar 1983. Contract AT03-82SF11687. 27p. NTIS, PC A03/MF A01. Order Number DE83010531.

This report presents the results of preliminary space reactor electric system integration studies performed by Rockwell International's Energy Systems Group (ESG). The preliminary studies investigated a broad range of reactor electric system concepts for powers of 25 and 100 KWe. The purpose of the studies was to provide timely system information of suitable accuracy to support ongoing mission planning activities. The preliminary system studies were performed by assembling the five different subsystems that are used in a system: the reactor, the shielding, the primary heat transport, the power conversion-processing, and the heat rejection subsystems. The subsystem data in this report were largely based on Rockwell's recently prepared Subsystem Technology Assessment Report. Nine generic types of reactor subsystems were used in these system studies. Several levels of technology were used for each type of reactor subsystem. Seven generic types of power conversion-processing subsystems were used, and several levels of technology were again used for each type. In addition, various types and levels of technology were used for the shielding, primary heat transport, and heat rejection subsystems. A total of 60 systems were studied.

2107 Regulation And Licensing

REFER ALSO TO CITATION(S) 29679, 29681, 29683

29594 **(CEA-CONF—6057) Technical regulation and the standardization in French nuclear safety.** Lebouleux, P.; Gilguy, C. (CEA Centre d'Etudes Nucleaires de Fontenay-aux-Roses, 92 (France)). Dec 1980. 15p. (In French). (CONF-8012106—1). NTIS (US Sales Only), PC A02/MF A01. Order Number DE83701501.

From ISO-AIEA seminar; Vienna, Austria (15 Dec 1980).

The general technical safety regulations were developed in France and in particular under the prompting of the public authorities so as to develop more detailed codes and standards for stipulating the rules applying to the various systems and materials constituting nuclear power stations. Furthermore, France takes an active part in the work of the IAEA, particularly with respect to the NUSSS programme and through AFNOR and UTE in the work of the ISO and CEI.

29595 **(DOE/NE—0030/7) US central station nuclear electric generating units: significant milestones. Status as of October 1, 1982.** (USDOE Assistant Secretary for Nuclear Energy, Washington, DC. Office of Converter Reactor Deployment). Mar 1983. 37p. NTIS, PC A03/MF A01. Order Number DE83010266.

Significant milestones in the planning, construction, and operation of US nuclear power plants are presented.

29596 **(NUREG—0580-Vol.12-No.3) Regulatory licensing status summary report. Nuclear power plants data for decisions (Blue Book), March 1-March 31, 1983.** (Nuclear Regulatory Commission, Washington, DC (USA). Office of Resource Management). Apr 1983. 23p. NTIS, PC A02/MF A01 - GPO. Order Number DE83901842.

Portions are illegible in microfiche products.

This management report, regulatory licensing status summary report, is designed to provide the necessary information for controlling the progress of review processes for central station nuclear reactor applications. Section 1 of this edition consists of the three summary of accomplishments, the new application forecast for ol's and cp's, and an abbreviation key. Section 2 represents the main body of the report and consists of the facility information. All ol's are listed first, followed by cp's, standard design reviews, other reviews, and finally, a non-power reactor summary. Each project consists of general facility data, current status for all phases of the review, and targeted and actual completion dates for all key milestones in the review.

29597 **(NUREG—0843-Suppl.3) Safety evaluation report related to the operation of St. Lucie Plant, Unit No. 2. Docket No. 50-389.** (Nuclear Regulatory Commission, Washington, DC (USA). Office of Nuclear Reactor Regulation). Apr 1983. 145p. NTIS, PC A07/MF A01 - GPO $6.50. Order Number DE83901633.

Information is presented concerning site characteristics, design characteristics, reactor coolant systems, engineered safety systems, instrumentation and controls, electric power systems, auxiliary systems, steam and power conversion system, radioactive waste management system, operations, accident analysis, and Three Mile Island-2 requirements.

2108 Economics

REFER ALSO TO CITATION(S) 29543, 29588

29598 **(AERE-R—10037) Fuel inventories and derived parameters for the reactor systems CDFR, LWR, AGR and MAGNOX.** Ewart, F.T. (UKAEA Atomic Energy Research Establishment, Harwell. Chemical Technology Div.). Apr 1981. 25p. NTIS (US Sales Only), PC A02/MF A01. Order Number DE83700384.

The results of computer calculations of the arisings of fission products and actinides from the reactor systems CDFR, LWR, AGR and Magnox are presented. The calculations give the inventory of the reactor fuel when discharged from the reactor and show how it changes with reprocessing and radioactive decay. The associated heat emissions and toxicities have also been calculated. The results are presented graphically, indicating the total and major contributing species, for activity, heat output and toxicity.

29599 **(DOE/ET/34013—6) Evaluation and demonstration of methods for improved nuclear-fuel utilization. Fifth semi-annual progress report, January 1-June 30, 1982.** Decher, U. (Combustion Engineering, Inc., Windsor, CT (USA); Arkansas Power and Light Co., Little Rock (USA)). Sep 1982. Contract AC02-79ET34013. 86p. (CEND—407). NTIS (US Sales Only), PC A05/MF A01. Order Number DE83010933.

The objective of this Department of Energy sponsored program is to demonstrate increased burnup for combustion Engineering 16 x 16 fuel. A demonstration of this improvement is in progress for the Arkansas Nuclear One Unit 2 (ANO-2) reactor located near Russellville, Arkansas. The extended burnup objective will be realized by demonstrating advanced fuel designs which should be capable of increasing batch average discharge exposure to 53 GWD/T and by demonstrating that the current fuel is capable of increasing batch average discharge exposure to 43 GWD/T. Analyses are included to assure that the extended burnup objective can be realized with both conventional and low leakage fuel management schemes. Advanced design fuel rods are experiencing their first exposure cycle during Reactor Cycle 2, which is scheduled for shutdown in August 1982. Current design 16 x 16 fuel assemblies are now in their second exposure cycle. One of these assemblies is scheduled to be irradiated for a fourth exposure cycle. This report presents fuel management analyses for transitions to extended burnup for ANO-2, and investigations of the adequacy of power distribution measurements at extended burnup.

2109 Process Heat Reactors

REFER ALSO TO CITATION(S) 29571

29600 **(GCRA—82-001) Current experience with central-station nuclear cogeneration plants.** Spellman, D.J.; McMain, A.T. Jr.; Penfield, S.R. Jr. (Gas-Cooled Reactor Associates, La Jolla, CA (USA)). 2 Dec 1981. Contract AC03-78SF02034. 63p. NTIS, PC A04/MF A01. Order Number DE83008098.

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In considering the potential of the HTGR for nuclear cogeneration, a logical element for investigation is the recent history of nuclear cogeneration experience. Little is found in recent literature; however, the twin nuclear cogeneration plant at Midland is nearing completion and this milestone will no doubt be the basis for a number of reports on the unique cogeneration facility and operating experiences with it. Less well known in the US is the Bruce Nuclear Power Development in Ontario, Canada. Originally designed to cogenerate steam for heavy water production, the Bruce facility is the focus of a major initiative to create an energy park on the shores of Lake Huron. To obtain an improved understanding of the status and implications of current nuclear cogeneration experience, GCRA representatives visited the Ontario Hydro offices in Toronto and subsequently toured the Midland site near Midland, Michigan. The primary purpose of this report is to summarize the results of those visits and to develop a series of conclusions regarding the implications for HTGR cogeneration concepts.

29601 **(GCRA—82-005) Direct steam-transmission design and costs. Final report.** (United Engineers and Constructors, Inc., Philadelphia, PA (USA)). Mar 1982. Contract AC03-78SF02034. 78p. NTIS, PC A05/MF A01. Order Number DE83007943.

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This report was prepared for Gas-Cooled Reactor Associates by United Engineers and Constructors under Contract No. GCRA/UE and C/81-203. This report presents the design and costs for a steam-transmission system sized to accommodate the output of an 1170 MW(t) HTGR Cogeneration Plant and deliver high-pressure steam to a potential process-heat user. The sensitivity of pipeline system costs to variations in important design parameters were investigated.

29602 **(GCRA—82-006(Rev.1)) High-temperature gas-cooled reactor steam cycle/cogeneration: lead project strategy plan.** (Gas-Cooled Reactor Associates, La Jolla, CA (USA)). Jul 1982. Contract AC03-78SF02034. 51p. NTIS, PC A04/MF A01. Order Number DE83007900.

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The strategy, contained herein, for developing the HTGR system and introducing it into the energy marketplace is based on using the most developed technology path to establish a HTGR-Steam Cycle/Cogeneration (SC/C) Lead Project. Given the status of the HTGR-SC/C technology, a Lead Plant could be completed and operational by the mid 1990s. While there is remaining design and technology development that must be accomplished to fulfill technical and licensing requirements for a Lead Project commitment, the major barriers to the realization a HTGR-SC/C Lead Project are institutional in nature, e.g. budget priorities and constraints, cost/risk sharing between the public and private sector, Project organization and management, and Project financing. These problems are further complicated by the overall pervading issues of economic and regulatory instability that presently confront the utility and nuclear industries. This document addresses the major institutional issues associated with the HTGR-SC/C Lead Project and provides a starting point for discussions between prospective Lead Project participants toward the realization of such a Project.

29603 **(GCRA—82-013) High-temperature gas-cooled reactor steam cycle/cogeneration: utility/user functional requirements.** (Gas-Cooled Reactor Associates, La Jolla, CA (USA)). Jul 1982. Contract AC03-78SF02034. 16p. NTIS, PC A02/MF A01. Order Number DE83007987.

The purpose of this document is to set forth the utility/user industry's functional requirements for the High Temperature Gas-Cooled Reactor Steam Cycle/Cogeneration (HTGR-SC/C) Lead Plant. Until the Lead Plant application is identified two design options are specified: (1) the Cogeneration Plant and (2) the Electric Generation Plant. The requirements contained in the document shall be considered applicable to both design options unless noted otherwise. This document constitutes along with identified regulatory, industrial, national and local codes and standards, the top-level requirements for developing the Overall Plant Design Specification (OPDS) and in turn, individual Structure and System Design Descriptions (SDDs) and as required, Component Specifications for major components in the plant.

29604 **(GCRA/UEC—82-007) HTGR for cogeneration applications: design and cost evaluation.** (United Engineers and Constructors, Inc., Philadelphia, PA (USA)). Dec 1981. Contract AC03-78SF02034. 222p. NTIS, PC A10/MF A01. Order Number DE83007966.

Portions are illegible in microfiche products.

This report, prepared for Gas-Cooled Reactor Associates by United engineers and Constructors Inc. under Contract No. GCRA/UE and C/81-203 presents a conceptual design and capital cost estimate for a reference 2240 MW(t) High Temperature Gas-Cooled Reactor Steam Cycle/Cogeneration (HTGR-SC/C) plant. In addition, an initial design and cost estimate has been prepared for a modified turbine plant which enables the HTGR-SC/C to operate in a variable cogeneration cycle ranging from maximum cogeneration to full electrical generation to satisfy a range of process steam supply requirements. In addition, the three available sizes for the HTGR are evaluated economically against comparably sized coal fired plants based on capital costs and cost of steam delivered to a process user.

29605 **(GCRA/UEC—82-008) High temperature gas-cooled reactor sensible energy transmission and storage concept screening report.** (United Engineers and Constructors, Inc., Philadelphia, PA (USA)). 1982. Contract AC03-78SF02034. 278p. NTIS, PC A13/MF A01. Order Number DE83007994.

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This report was prepared for Gas-Cooled Reactor Associates by United Engineers and Constructors under contract No. GCRA/UE and C-81-203. It summarizes and integrates the results of studies conducted during GFY 1981 and 1982 related to the design and application of an HTGR nuclear heat source and heat transport and storage system using a molten nitrate salt as the working fluid. A preliminary conceptual design is presented and alternative configurations leading to the reference design are discussed. Product costs for six applications requiring either direct heat, process steam, and/or electricity were developed and compared to fossil or steam cycle HTGR alternatives. Recommendations and conclusions regarding future work on the HTGR-SETS system are drawn. Significant portions of the report were prepared by the General Atomic Company and GCRA.

29606 **(GEFR—00602-Vol.1) Gas-Cooled Thermal Reactor Program. Annual technical progress report for the period ending September 30, 1981.** (General Electric Co., Sunnyvale, CA (USA). Advanced Reactor Systems Dept.). Mar 1982. Contract AC03-80ET34034. 302p. NTIS, PC A14/MF A01. Order Number DE83010922.

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This report provides descriptions and results of the technical effort during FY81 on the Gas-Cooled Thermal Reactor Program. The FY81 work was organized according to the Work Breakdown Structure (WBS) for the National HTGR Program, and fell within five of the WBS tasks. The work on Market Definition and Development (WBS 03) was associated with estimating product costs for HTGR systems and their alternatives, projecting markets and market penetrations for these systems, and providing costs and market input to application analyses and component design. The Plant Technology (WBS 13) effort was mainly in the development of the systems dynamic computer code, STAR, for the transient analysis of HTGR's in reformer applications. The analysis of pebble bed reactors (PBR) was performed under Technology Transfer (WBS 15). The effort on components and systems within the nuclear heat source for reforming plants was performed under High Temperature Nuclear Heat Source (WBS 42).

29607 **(GEFR—00602-Vol.2) Gas-Cooled Thermal Reactor Program. Annual technical progress report for the period ending September 30, 1981.** (General Electric Co., Sunnyvale, CA (USA). Advanced Reactor Systems Dept.). Mar 1982. Contract AC03-80ET34034. 413p. NTIS, PC A18/MF A01. Order Number DE83010923.

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The task on High Temperature Process Heat Applications (WBS 44) includes assessments of the various process heat applications of the HTGR and the design and evaluation of systems and components outside the nuclear heat source. The application assessment established criteria for evaluating various synfuel processes, and investigated processes in coal gasification, oil shale processing, coal liquefaction, and water splitting to identify areas where HTGR-produced heat could be substituted for the presently used fossil heat. Conceptual designs were developed for the process gas systems in the 950°C direct cycle and the 850°C indirect cycle plants and for methanation systems coupled to various synfuel processing applications. The components evaluated under this task were methanator, the indirect cycle steam reformer, and the heat exchangers in the process gas train. Methods of controlling the process gas system were also investigated. A technology development plan for reformer plants and components was prepared.

22 NUCLEAR REACTOR TECHNOLOGY

29608 **Structural mechanics in reactor technology. Vol. B. Thermal and fluid - structure dynamics analysis.** Amsterdam, Netherlands; North-Holland Publishing Co. (1981). vp. (CONF-810801—Vol.B).

From 6. international conference on structural mechanics in reactor technology; Paris, France (17 Aug 1981).

Individual items in scope for the data base are processed separately. (DLC)

2201 Theory And Calculation

REFER ALSO TO CITATION(S) 29586

29609 **(CEA-CONF—6146) Effects of cell asymmetry on the performance of a large heterogeneous critical assembly.** Scholtyssek, W.; Humbert, G.; Martini, M.; Norvez, G. (CEA Centre d'Etudes Nucleaires de Cadarache, 13 - Saint-Paul-les-Durance (France)). Sep 1981. 26p. (CONF-810975—2). NTIS (US Sales Only), PC A03/MF A01. Order Number DE83700229.

From Meeting of the Nuclear Energy Agency Committee on reactor physics; Winfrith, Dorset, UK (14 Sep 1981).

Calculations were performed to investigate asymmetry effects observed in the RACINE reference configuration. The perturbation sources -material shifts in fissile rodlet cells- were identified and influences on various experimental parameters were estimated. Improvements of the relatively simple methods used in this work could lead to applications, considering similar effects, in project calculations for large power reactor cores.

29610 **(CEA-CONF—6147) Heterogeneity effects in Masurca rodlet cells.** Salvatores, M.; Rimpault, G.; Soule, R. (CEA Centre d'Etudes Nucleaires de Cadarache, 13 - Saint-Paul-les-Durance (France)). Sep 1981. 20p. (CONF-810975—3). NTIS (US Sales Only), PC A02/MF A01. Order Number DE83700230.

From Meeting of the Nuclear Energy Agency Committee on reactor physics; Winfrith, Dorset, UK (14 Sep 1981).

Recent studies on the heterogeneity effects in MASURCA pin cells, were related to: two dimensional effects; fertile cell heterogeneity; pin/plate heterogeneity experiment planning. Streaming effects are also being investigated. The present paper will deal in particular, with the first three points.

29611 **(CTA-EAV-NT—019/80) Comparative study of the systems for neutronics calculations used in Los Alamos Scientific Laboratory (LASL) and Argonne National Laboratory (ANL).** do Amorim, E.S.; D'Oliveira, A.B.; Oliveira, E.C. de. (Centro Tecnico Aeroespacial, Sao Jose dos Campos (Brazil). Inst. de Atividades Espaciais). Nov 1980. 18p. (In Portuguese). NTIS (US Sales Only), PC A02/MF A01. Order Number DE83701514.

A comparative study of the systems for neutronics calculations used in Los Alamos Scientific Laboratory (LASL) and Argonne National Laboratory (ANL) has been performed using benchmark results available in the literature, in order to analyse the convenience of using the respective codes MINX/NJOY and ETOE/MC²-2 for performing neutronics calculations in course at the Divisao de Estudos Avancados.

29612 **Flow-induced vibration of circular cylindrical structures - 1982.** Chen, S.S.; Paidoussis, M.P.; Au-Yang, M.K. . (Argonne Natl Lab, IL, USA). *American Society of Mechanical Engineers, Pressure Vessels and Piping Division, [Technical Report] PVP;* **63**: 223(1982). (CONF-820601—).

This conference proceedings contains 16 papers of which 11 are abstracted separately. Topics covered include: fluid - force characterization for circular cylinders in fluid; dynamic instability of tube banks in cross flow; axial flow-induced vibrational response; and, acoustoelastic and fluidelastic vibration.

29613 **Simulation of thermal transient induced pipe flow stratification using COMMIX-2.** Shah, V.L.; Domanus, H.M.; Miao, C.C.; Schmitt, R.C.; Sha, W.T. (Argonne Natl Lab, IL, USA). *American Society of Mechanical Engineers, Pressure Vessels and Piping Division, [Technical Report] PVP;* **64**: 91-105(1982). (CONF-820601—).

At low-flow (high Richardson number) conditions in a piping system with thermal-transients, there is thermal-buoyancy-induced secondary flow. Three-dimensional computer codes are, therefore, necessary to model correctly the non-axisymmetric, thermally stratified flow through a piping system. The results are presented of the numerical simulation of thermal-hydraulic behavior in a pipe during a thermal transient. The particular transient considered was the experimental test #PIPE2, and carried out at the Mixing Components Test Facility (MCTF), Argonne National Laboratory. The numerical simulation was performed using COMMIX-2. COMMIX-2 is a computer code for steady/unsteady, three-dimensional, two-phase thermal-hydraulic analysis of reactor components under normal and off-normal operating conditions. The results of simulation are compared with the experimental measurements and they are in reasonable agreement with experimental data. 4 refs.

2202 Components And Accessories

REFER ALSO TO CITATION(S) 29499, 29693, 29700

29614 **Apparatus for and method of monitoring for breached fuel elements.** Gross, K.C.; Strain, R.V. US Patent Application 6-258,351. 28 Apr 1981. 28p. Contract W-31-109-ENG-38.

This invention teaches improved apparatus for the method of detecting a breach in cladded fuel used in a nuclear reactor. The detector apparatus uses a separate bypass loop for conveying part of the reactor coolant away from the core, and at least three separate delayed-neutron detectors mounted proximate this detector loop. The detectors are spaced apart so that the coolant flow time from the core to each detector is different, and these differences are known. The delayed-neutron activity at the detectors is a function of the delay time after the reaction in the fuel until the coolant carrying the delayed-neutron emitter passes the respective detector. This time delay is broken down into separate components including an isotopic holdup time required for the emitter to move through the fuel from the reaction to the coolant at the breach, and two transit times required for the emitter now in the coolant to flow from the breach to the detector loop and then via the loop to the detector.

2203 Fuel Elements

REFER ALSO TO CITATION(S) 29591, 29900

29615 **(CEA-CONF—6081) "Fabrice" process for reconstituting experimental rods in a hot cell from pre-irradiated rods in power reactors.** Houdaille, B.; Vignesoult, N.; Atabek, R. (CEA Centre d'Etudes Nucleaires de Saclay, 91 - Gif-sur-Yvette (France)). Nov 1981. 22p. (In French). (CONF-811157—3). NTIS (US Sales Only), PC A02/MF A01. Order Number DE83701530.

From IAEA specialists' meeting on examination of fuel assembly for water cooled power reactors; Tokyo, Japan (9 Nov 1981).

The Fabrice process for the "hot cell refabrication" of small rods from very long irradiated fuel elements was developed by the CEA, particularly to enable parametric studies to be carried out on the behaviour under irradiation of rods from power stations. This technique, although requiring intricate operations in a hot cell with specially adapted equipment and a very experienced personnel, enables (1) a significant saving to be made compared with the pre-irradiation of new rods and (2) affords a virtually unlimited choice of rod sections irradiated in a power reactor for parametric irradiations. Tests have shown that the initial characteristics of the sample rod are not modified and that the behaviour under irradiation of whole non-refabricated rods and Fabrice rods with the same initial characteristics is identical, for a local specific burn-up under 40,000 MWd/t, vis-a-vis the fuel cladding interaction phenomenon.

29616 **Technique for controlling shrinkage distortion in cold-pressed annular pellets.** Johnson, R.G.R.; Burke, T.J. US Patent Application 6-392,498. 28 Jun 1982. 14p. Contract AC11-76PN00014.

A process and apparatus are described for the production of annular fuel pellets comprising locating particulate fuel material in a compaction chamber having side walls, a moveable punch located opposite a fixed member and a frustoconical element having a taper of between about 0.010 to 0.015 inches/inch located in about the center of the chamber. The punch is moved toward the fixed surface to compact the particulate material. The compacted pellet is fired to produce sintered pellets having substantially straight inner side walls essentially parallel to the pellet axis.

29617 **Method and apparatus for measuring irradiated fuel profiles.** Lee, D.M. (to Dept. of Energy). US Patent 4,335,466. 15 Jun 1982. Filed date 27 Mar 1980. vp. PAT-APPL-134352.

A new apparatus is used to substantially instantaneously obtain a profile of an object, for example a spent fuel assembly, which profile (when normalized) has unexpectedly been found to be substantially identical to the normalized profile of the burnup monitor Cs-137 obtained with a germanium detector. That profile can be used without normalization in a new method of identifying and monitoring in order to determine for example whether any of the fuel has been removed. Alternatively, two other new methods involve calibrating that profile so as to obtain a determination of fuel burnup (which is important for complying with safeguards requirements, for utilizing fuel to an optimal extent, and for storing spent fuel in a minimal amount of space). Using either of these two methods of determining burnup, one can reduce the required measurement time significantly (by more than an order of magnitude) over existing methods, yet retain equal or only slightly reduced accuracy.

2204 Control Systems

REFER ALSO TO CITATION(S) 29624

29618 **(CEA-CONF—6148) Control rod experiments in Racine.** Stanculescu, A.; Humbert, G. (CEA Centre d'Etudes Nucleaires de Cadarache, 13 - Saint-Paul-les-Durance (France)). Sep 1981. 16p. (CONF-810975—4). NTIS (US Sales Only), PC A02/MF A01. Order Number DE83700231.

From Meeting of the Nuclear Energy Agency Committee on reactor physics; Winfrith, Dorset, UK (14 Sep 1981).

A survey of the control-rod experiments planned within the joint CEA/CNEN-DeBeNe critical experiment RACINE is given. The applicability to both heterogeneous and homogeneous large power LMFBR-cores is discussed. Finally, the most significant results of the provisional design calculations performed on behalf of the RACINE control-rod programme are presented.

29619 **(EGG-M—30182) Data analysis through interactive computer animation method (DATICAM).** Curtis, J.N.; Schwieder, D.H. (EG and G Idaho, Inc., Idaho Falls (USA)). 1983. Contract AC07-76ID01570. 9p. (CONF-830346—1). NTIS, PC A02/MF A01. Order Number DE83010398.

From Computer animation method conference; Berlin, F.R. Germany (14 Mar 1983).

DATICAM is an interactive computer animation method designed to aid in the analysis of nuclear research data. DATICAM was developed at the Idaho National Engineering Laboratory (INEL) by EG and G Idaho, Inc. INEL analysts use DATICAM to produce computer codes that are better able to predict the behavior of nuclear power reactors. In addition to increased code accuracy, DATICAM has saved manpower and computer costs. DATICAM has been generalized to assist in the data analysis of virtually any data-producing dynamic process.

29620 **Digital computer operation of a nuclear reactor.** Colley, R.W. US Patent Application 6-393,286. 29 Jun 1982. 80p. Contract AC06-76FF02170.

A method is described for the safe operation of a complex system such as a nuclear reactor using a digital computer. The computer is supplied with a data base containing a list of the safe state of the reactor and a list of operating instructions for achieving a safe state when the actual state of the reactor does not correspond to a listed safe state, the computer selects operating instructions to return the reactor to a safe state.

2205 Environmental Aspects

REFER ALSO TO CITATION(S) 29143, 29692, 30347

29621 **(LUNFD6/NFFR—1005/1-18(1982)) Sewage sludge as a sensitive indicator for airborne radionuclides from nuclear power plants. Studies of distribution and behaviour of activation products in the terrestrial environment.** Ingemansson, T. (Lund Univ. (Sweden). Fysiska Institutionen). 1 Jun 1982. 100p. NTIS (US Sales Only), PC A05/MF A01. Order Number DE83700480.

Sewage sludge collected at waste water treatment plants located in the vicinity of nuclear power stations, has been shown to be a sensitive and convenient indicator for airborne locally released activation products, ^{60}Co, ^{65}Zn, ^{58}Co and ^{54}Mn. We have therefore been able to study the distribution and behaviour of these radionuclides in the terrestrial environment of three Swedish nuclear power stations. Comparative measurements on ground level air and on samples of lichen (Cladonia alpestris) and soil have also been performed. The variation by distance from the power station of ^{60}Co measured in sludge as well as on air-filters could be described by the same power function. The temporal variation of the activity concentration in sludge samples well reflects the variation of the reported release rate of airborne radionuclides from the power stations if the prevalent wind direction is taken into consideration. The relation between the activity ratio ^{60}Co/ ^{7}Be in air and in sludge was investigated and indicated that most of the detected ^{60}Co and part of ^{58}Co and ^{54}Mn activity is released from a local source and is dry deposited on the ground before it is washed off by rain.

2206 Research, Test, And Experimental Reactors

REFER ALSO TO CITATION(S) 29582

29622 (CEA-CONF—5826) French LEU fuel for research reactor with emphasis on the Osiris experience of core conversion and reactor operation with the new fuel. Cerles, J.M.; Trotabas, M.; de Contenson, G.; Delafosse, J. (CEA Centre d'Etudes Nucleaires de Saclay, 91 - Gif-sur-Yvette (France)). Sep 1981. 25p. (CONF-8109117—3). NTIS (US Sales Only), PC A02/MF A01. Order Number DE83701499.

From Seminar on research reactor operation and use; Juelich, F.R. Germany (14 Sep 1981).

One of the various activities carried out in France concerned with the design, fabrication and development of nuclear fuels was the development by the CEA of a plate type fuel (Caramel fuel). A Caramel fuel element is in the form of a plate consisting of two tight covering zircaloy sheets in which the UO_2 platelets are confined themselves within the network of a zircaloy grid. The plane geometry provides an effective means of overcoming the drawback of poor uranium oxide conductivity, and makes it possible to combine high specific power with low fuel temperature. The chief advantages of this fuel are the following: it is a very low enriched fuel. It can be used in research reactors demanding high volumetric powers and neutron fluxes, with a required enrichment significantly lower than 20% ^{235}U. The difference between the densities of UO_2 matrix and U-Al, 10.3 and 1.6 g/cm respectively, leads to a higher uranium charge, making it possible to reduce the enrichment to between 3 and 10%. Owing to fuel dispersion, any loss of tightness only puts a small amount of fissile material in contact with the coolant, thus limiting any contamination of the primary circuit. Another safety factor is the operating temperature, which is considerably lower than the temperature at which fission gases are liberated.

29623 (INR—1913) Reactor Power Meter type SG-8. Glowacki, S.W. (Institute of Nuclear Research, Warsaw (Poland)). 1981. 11p. (In Polish). Energetics and Atomic Energy Information Centre, Warsaw, Poland.

The report describes the principle and electronic circuits of the Reactor Power Meter type SG-8. The gamma radiation caused by the activity of the reactor first cooling circuit affectes the ionization chamber being the detector of the instrument. The output detector signal direct current is converted into the frequency of electric pulses by means of the current-to-frequency converter. The output converter frequency is measured by the digital frequency meter: the number of measured digits in time unit is proportional to the reactor power.

2208 Propulsion Reactors

REFER ALSO TO CITATION(S) 29648

2209 Reactor Safety

REFER ALSO TO CITATION(S) 29597, 30345

29624 (AAEC-LIB/Trans—761) Taking human error into account in the design of nuclear reactor centres. Prouillac; Lerat; Janoir. (Australian Atomic Energy Commission Research Establishment, Lucas Heights). May 1982. 18p. NTIS (US Sales Only), PC A02/MF A01. Order Number DE83700478.

Translated from Revue generale nucleaire, Sep - Oct 1981.

The role of the operator in the centralized management of pressurized water reactors is studied. Different types of human error likely to arise, the means of their prevention and methods of mitigating their consequences are presented. Some possible improvements are outlined.

29625 (AAEC-LIB/Trans—762) Significance of the human factor in the safety of nuclear reactors: the French experience and the lessons of Three Mile Island. Houze, C.; Oury, J.M. (Australian Atomic Energy Commission Research Establishment, Lucas Heights). May 1982. 19p. NTIS (US Sales Only), PC A02/MF A01. Order Number DE83700479.

Translated from Revue generale nucleaire, Sep - Oct 1981.

The importance of the human factor to French nuclear safety policy and the application of human fallibility as a parameter of safety analysis are described. The impact of reactor operating experience on future theoretical and practical application considerations is discussed. Particular reference is given to the lessons of Three Mile Island.

29626 (CONF-810501—5) Code portability and data management considerations in the SAS3D LMFBR accident-analysis code. Dunn, F.E. (Argonne National Lab., IL (USA)). 1981. Contract W-31-109-ENG-38. 21p. NTIS, PC A02/MF A01. Order Number DE83010583.

From National computer conference; Chicago, IL, USA (4 May 1981).

The SAS3D code was produced from a predecessor in order to reduce or eliminate interrelated problems in the areas of code portability, the large size of the code, inflexibility in the use of memory and the size of cases that can be run, code maintenance, and running speed. Many conventional solutions, such as variable dimensioning, disk storage, virtual memory, and existing code-maintenance utilities were not feasible or did not help in this case. A new data management scheme was developed, coding standards and procedures were adopted, special machine-dependent routines were written, and a portable source code processing code was written. The resulting code is quite portable, quite flexible in the use of memory and the size of cases that can be run, much easier to maintain, and faster running. SAS3D is still a large, long running code that only runs well if sufficient main memory is available.

29627 (CONF-820601—29) Probabilistic assessment of critically flawed LMFBR PHTS piping elbows. Balkey, K.R.; Wallace, I.T.; Vaurio, J.K. (Westinghouse Electric Corp., Madison, PA (USA). Advanced Reactors Div.; Argonne National Lab., IL (USA)). 1982. Contract W-31-109-ENG-38. 18p. NTIS, PC A02/MF A01. Order Number DE83010781.

From ASME pressure vessel and piping conference; Orlando, FL, USA (27 Jun 1982).

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One of the important functions of the Primary Heat Transport System (PHTS) of a large Liquid Metal Fast Breeder Reactor (LMFBR) plant is to contain the circulating radioactive sodium in components and piping routed through inerted areas within the containment building. A significant possible failure mode of this vital system is the development of cracks in the piping components. This paper presents results from the probabilistic assessment of postulated flaws in the most-critical piping elbow of each piping leg. The criticality of calculated maximum sized flaws is assessed against an estimated material fracture toughness to determine safety factors and failure probability estimates using stress-strength interference theory. Subsequently, a different approach is also employed in which the randomness of the initial flaw size and loading are more-rigorously taken into account. This latter approach yields much smaller probability of failure values when compared to the stress-strength interference analysis results.

29628 (CONF-820704—48) New aspects in the analysis of loss-of-flow transients for homogeneous and heterogeneous LMFBR cores. Tentner, A.M.; Wider, H.U. (Argonne National Lab., IL (USA)). 1982. Contract W-31-109-ENG-38. 8p. NTIS, PC A02/MF A01. Order Number DE83009491.

From International topical meeting on LMFBR safety; Lyon, France (18 Jul 1982).

This paper presents the results of analyses of unprotected loss-of-flow (LOF) transients which have been performed to date using the new SAS4A code system. Accident histories for homogeneous and heterogeneous demo-sized cores (300 MWe) are compared and emphasis is placed on phenomena occurring after the ini-

tiation of fuel motion as described by LEVITATE. LEVITATE is the SAS4A model for the analysis of fuel and cladding dynamics under loss-of-flow (LOF) conditions and is believed to be the most-sophisticated computational tool currently available for fuel-motion analysis. The results of this analysis indicate that the initiation phase of an unprotected loss-of-flow accident has a considerably lower energetics potential in a heterogeneous core than in a homogeneous core. The difference is larger than previously indicated by SAS3D. Better phenomenological models implemented in SAS4A provide increased confidence in this aspect of safety evaluation of LMFBR cores.

29629 **(CONF-820704—49) Results of recent fuel-coolant interaction experiments with reactor materials.** Cho, D.H.; Spencer, B.W.; Armstrong, D.R.; Wilson, R. (Argonne National Lab., IL (USA)). 1982. Contract W-31-109-ENG-38. 6p. NTIS, PC A02/MF A01. Order Number DE83009691.

From International topical meeting on LMFBR safety; Lyon, France (18 Jul 1982).

The results of reactor-material experiments on fuel-coolant interaction recently performed at Argonne National Laboratory are summarized. Two types of experiments were conducted. The first type involves experiments of an exploratory nature on the interaction between molten uranium carbide and sodium, whereas the second type is concerned with the interaction between molten uranium dioxide and sodium in reactor pin-bundle geometries.

29630 **(CONF-820704—50) Status of core-debris coolability experiments with real and simulant materials at Argonne National Laboratory.** Pedersen, D.R.; Sowa, E.; Gabor, J.D.; Jones, S.; Baker, L. Jr.; Epstein, M. (Argonne National Lab., IL (USA); Fauske and Associates, Willowbrook, IL (USA)). 1982. Contract W-31-109-ENG-38. 5p. NTIS, PC A02/MF A01. Order Number DE83008929.

From International topical meeting on LMFBR safety; Lyon, France (18 Jul 1982).

The two major areas of interest in the debris-bed coolability experiments at ANL are: (1) development of a data base against which existing debris bed coolability models can be compared and to provide insight into the development of future models and (2) investigation of the possible mechanisms which prevent channel formation in a debris bed with real material experiments. The mechanism under consideration are: (a) subcooling of overlying sodium, (b) UO/sub 2+x/ reduction by sodium, (c) failure of the sodium to wet the fuel and (d) concrete reaction products. Sandia has proposed that subcooling of the overlying sodium is sufficient to prevent channel formation and was the cause of the observed reduction in coolability with increasing subcooling. The results of experiments on each of the mechanisms are to be presented.

29631 **(CONF-820704—51) Review of recent ANL safety experiments in SLSF and TREAT.** Klickman, A.E.; Thompson, D.H.; Ragland, W.A.; Wright, A.E.; Palm, R.G.; Page, R.J. (Argonne National Lab., IL (USA)). 1982. Contract W-31-109-ENG-38. 10p. NTIS, PC A02/MF A01. Order Number DE83009034.

From International topical meeting on LMFBR safety; Lyon, France (18 Jul 1982).

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Among the recent significant in-pile experiments conducted by ANL are Sodium Loop Safety Facility (SLSF) experiment P4 in the Engineering Test Facility (ETR) and TREAT experiments F3, F4, and J1. The P4 experiment, which had three heat-generating flow blockages each installed in six coolant channels in a 37-pin bundle of FTR (Fast Test Reactor)-type fuel elements, investigated the bounding consequences of severe local faults. The principal objectives were to eject molten fuel into the bundle geometry and, during subsequent extended operation, to characterize the behavior of (and response of instrumentation to) any subsequent blockage growth; secondary objectives included characterizing the severity of any molten-fuel/coolant interaction and the response of the coolant. The F3 and F4 experiments in TREAT were phenomenological tests to study the fuel-column disruption mode in loss-of-flow accidents. The J1 experiment was the first slow period (~ 10 s) transient overpower experiment done in TREAT. Results of these experiments will be presented.

29632 **(CONF-820810—19) Thermal-hydraulic posttest analysis for the ANL/MCTF 360° model heat-exchanger water test under mixed convection.** Yang, C.I.; Sha, W.T.; Kasza, K.E. (Argonne National Lab., IL (USA)). 1982. Contract W-31-109-ENG-38. 8p. NTIS, PC A02/MF A01. Order Number DE83009037.

From 10. international mathematics and computers simulation congress on systems simulation and scientific computation; Montreal, Canada (9 Aug 1982).

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As a result of the uncertainties in the understanding of the influence of thermal-buoyancy effects on the flow and heat transfer in Liquid Metal Fast Breeder Reactor heat exchangers and steam generators under off-normal operating conditions, an extensive experimental program is being conducted at Argonne National Laboratory to eliminate these uncertainties. Concurrently, a parallel analytical effort is also being pursued to develop a three-dimensional transient computer code (COMMIX-IHX) to study and predict heat exchanger performance under mixed, forced, and free convection conditions. This paper presents computational results from a heat exchanger simulation and compares them with the results from a test case exhibiting strong thermal buoyancy effects. Favorable agreement between experiment and code prediction is obtained.

29633 **(CONF-820810—20) SASSYS LMFBR systems analysis code.** Dunn, F.E.; Prohammer, F.G. (Argonne National Lab., IL (USA)). 1982. Contract W-31-109-ENG-38. 4p. NTIS, PC A02/MF A01. Order Number DE83010759.

From 10. international mathematics and computers simulation congress on systems simulation and scientific computation; Montreal, Canada (9 Aug 1982).

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The SASSYS code provides detailed steady-state and transient thermal-hydraulic analyses of the reactor core, inlet and outlet coolant plenums, primary and intermediate heat-removal systems, steam generators, and emergency shut-down heat removal systems in liquid-metal-cooled fast-breeder reactors (LMFBRs). The main purpose of the code is to analyze the consequences of failures in the shut-down heat-removal system and to determine whether this system can perform its mission adequately even with some of its components inoperable. The code is not plant-specific. It is intended for use with any LMFBR, using either a loop or a pool design, a once-through steam generator or an evaporator-superheater combination, and either a homogeneous core or a heterogeneous core with internal-blanket assemblies.

29634 **(CONF-830301—12) Development of a generalized correlation for phase-velocity measurements obtained from impedance-probe pairs in two-phase flow systems.** Hsu, C.T.; Keshock, E.G.; McGill, R.N. (Tennessee Univ., Knoxville (USA); Oak Ridge National Lab., TN (USA)). 1983. Contract W-7405-ENG-26. 9p. NTIS, PC A02/MF A01. Order Number DE83009860.

From ASME-JSME thermal engineering joint conference; Honolulu, HI, USA (20 Mar 1983).

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A flag type electrical impedance probe has been developed at the Oak Ridge National Lab (ORNL) to measure liquid- and vapor-phase velocities in steam-water mixtures flowing through rod bundles. Measurements are made by utilizing the probes in pairs, installed in line, parallel to the flow direction, and extending out into the flow channel. The present study addresses performance difficulties by examining from a fundamental point of view the two-phase flow system which the impedance probes typically operate in. Specifically, the governing equations (continuity, momentum, energy) were formulated for both air-water and steam-water systems, and then subjected to a scaling analysis. The scaling analysis yielded the appropriate dimensionless parameters of significance in both kinds of systems. Additionally, with the aid of experimental data obtained at ORNL, those parameters of significant magnitude were established. As a result, a generalized correlation was developed for liquid and vapor phase velocities that makes it possible to employ the impedance probe velocity measurement technique in a wide variety of test configurations and fluid combinations.

29635 **(CONF-830439—1) First-order model for non-equilibrium ECC pressure suppression.** Lyczkowski, R.W. (Argonne National Lab., IL (USA)). 1983. Contract W-31-109-ENG-38. 27p. NTIS, PC A03/MF A01. Order Number DE83009590.

From 3. multi-phase flow and heat transfer symposium; Miami, FL, USA (18 Apr 1983).

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Closed-form analytical solutions have been obtained which account for non-equilibrium pressure suppression during ECC injection. The mathematical model uses the two-fluid theory of two-phase flow. Many assumptions have to be made in order to obtain the analytical solutions; however, they appear to be reasonable since agreement with experimental data is possible. These assumptions can be lifted but then numerical methods would have to be employed to solve the equations. The objective of this paper is to identify the controlling mechanisms involved in the non-equilibrium pressure-suppression process and to describe basic trends. If all the assumptions were to be lifted, the full two-fluid theory would result. In other words, the model can be made as sophisticated as one wants by merely making fewer assumptions. It has been found that the heating of the jet is a first-order effect relatively insensitive to assumptions and that the pressure-suppression effect is second order and relatively sensitive to the assumptions made. The so-called pressure undershoot is predicted.

29636 **(CONF-830439—3) Hydrodynamic and thermal modeling of solid particles in a multi-phase, multi-component flow.** Tentner, A.M.; Wider, H.U. (Argonne National Lab., IL (USA)). 1983. Contract W-31-109-ENG-38. 12p. NTIS, PC A02/MF A01. Order Number DE83010752.

From 3. multi-phase flow and heat transfer symposium; Miami, FL, USA (18 Apr 1983).

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This paper presents the new thermal hydraulic models describing the hydrodynamics of the solid fuel/steel chunks during an LMFBR hypothetical core-disruptive accident. These models, which account for two-way coupling between the solid and fluid phases, describe the mass, momentum, and energy exchanges which occur when the chunks are present at any axial location. They have been incorporated in LEVITATE, a code for the analysis of fuel and cladding dynamics under Loss-of-Flow (LOF) conditions. Their influence on fuel motion is presented in the context of the L6 TREAT experiment analysis. It is shown that the overall hydrodynamic behavior of the molten fuel and solid-fuel chunks is dependent on both the size of the chunks and the power level. At low and intermediate power levels the fuel motion is more dispersive when small chunks, rather than large ones, are present. At high power levels the situation is reversed. These effects are explained in detail.

29637 **(CONF-8110264—2) PWR systems transient analysis.** Kennedy, M.F. (Argonne National Lab., IL (USA)). 1981. Contract W-31-109-ENG-38. 63p. NTIS, PC A04/MF A01. Order Number DE83009576.

From ANL/International Centre for Heat and Mass Transfer course on LWRs; Belgrad, Yugoslavia (11 Oct 1981).

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The transient analysis of pressurized-water-reactor (PWR) systems involves the assessment of the response of the total plant including primary and secondary coolant systems, steam piping and turbine (possibly including the complete feedwater train), and various control and safety systems to a number of event sequences which are developed by considering possible failures or maloperations of plant components. This analysis is performed as part of the plant safety analysis to insure the adequacy of the reactor design and operating procedures and to verify the applicable plant emergency guidelines. The event sequences which are considered vary in severity (and calculational difficulty) from a series of normal operational transients including minor load changes, reactor trips, valve and pump malfunctions up to the double-ended guillotine rupture of a primary reactor coolant system pipe. The focus of this discussion is on the analysis of all transients and accidents excluding the loss of coolant accident.

29638 **(CONF-8110266—1) Quantitative software reliability in nuclear safety.** Komoriya, H.; Mueller, C.J.; Morris, E.E. (Argonne National Lab., IL (USA)). 1981. Contract W-31-109-ENG-38. 10p. NTIS, PC A02/MF A01. Order Number DE83009673.

From International ANS/ENS topical meeting on probabilistic risk assessment; Port Chester, NY, USA (20 Oct 1981).

Applications of computer software that are critical to nuclear safety include both on-line protection systems and design and safety assessment programs. This summary compares existing quantitative methods for estimating software reliability. Results of the application of these methods to software failure data are presented with deficiencies and potential improvements in the models discussed. Finally, the relevance and application of these models for use in calculating the computer software component of nuclear risk is summarized.

29639 **(DOE/NBM—3008900) Calculational limitations in PWR system analysis.** Abramson, P.B. (Argonne National Lab., IL (USA)). 1981. Contract W-31-109-ENG-38. 14p. NTIS, PC A02/MF A01. Order Number DE83008900.

Systems transient-analysis codes can be expected to yield reasonably accurate results (order +-20% or so on system pressure) if carefully utilized and if the two-phase and transient-flow conditions are not severe. As the severity of the transient increases, the confidence that one may have in the results decreases. None of the existing codes is well assessed or verified for transient analysis, but all give qualitatively the same results, lending credence to their results. Users of these codes must be especially careful to initialize properly, must examine results with great concern for understanding the details in order to uncover anomalous behavior, and must, over everything, take great lengths to accurately model the plant controls which will in fact ultimately govern the transient.

29640 **(EGG-M—02483) Review of solution approach, methods, and recent results of the RELAP5 system code.** Trapp, J.A.; Ransom, V.H. (EG and G Idaho, Inc., Idaho Falls (USA); Practical Analysis and Computing, Inc., Denver, CO (USA)). 1983. Contract AC07-76ID01570. 16p. (CONF-830304—18). NTIS, PC A02/MF A01. Order Number DE83010442.

From American Nuclear Society topical conference on computational methods; Salt Lake City, UT, USA (28 Mar 1983).

The present RELAP5 code is based on a semi-implicit numerical scheme for the hydrodynamic model. The basic guidelines employed in the development of the semi-implicit numerical scheme are discussed and the numerical features of the scheme are illustrated by analysis for a simple, but analogous, single-equation model. The basic numerical scheme is recorded and results from several simulations are presented. The experimental results and code simulations are used in a complementary fashion to develop insights into nuclear-plant response that would not be obtained if either tool were used alone. Further analysis using the simple single-equation model is carried out to yield insights that are presently being used to implement a more-implicit multi-step scheme in the experimental version of RELAP5. The multi-step implicit scheme is also described.

29641 **(EGG-M—29782) Some applications of the moving finite element method to fluid flow and related problems.** Berry, R.A.; Williamson, R.L. (EG and G Idaho, Inc., Idaho Falls (USA)). 1983. Contract AC02-76CH00016. 14p. (CONF-830304—19). NTIS, PC A02/MF A01. Order Number DE83010399.

From American Nuclear Society topical conference on computational methods; Salt Lake City, UT, USA (28 Mar 1983).

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The Moving Finite Element (MFE) method is applied to one-dimensional, nonlinear wave type partial differential equations which are characteristics of fluid dynamic and related flow phenomena problems. These equation systems tend to be difficult to solve because their transient solutions exhibit a spacial stiffness property, i.e., they represent physical phenomena of widely disparate length scales which must be resolved simultaneously. With the MFE method the node points automatically move (in theory) to optimal locations giving a much better approximation than can be

obtained with fixed mesh methods (with a reasonable number of nodes) and with significantly reduced artificial viscosity or diffusion content. Three applications are considered. In order of increasing complexity they are: (1) a thermal quench problem, (2) an underwater explosion problem, and (3) a gas dynamics shock tube problem. The results are briefly shown.

29642 (EPRI-NP—2494-SR) **Conference proceedings: second international RETRAN conference.** Agee, L.J. (ed.). (Electric Power Research Inst., Palo Alto, CA (USA). Nuclear Power Div.). Jul 1982. 734p. (CONF-820455—). NTIS, PC A99/MF A01. Order Number DE82905838.

From 2. international RETRAN meeting; San Diego, CA, USA (28 Apr 1982).

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The RETRAN computer code, developed by EPRI through its Contractor, Energy Incorporated (EI), is now being widely used by the international nuclear community for various types of safety analysis. In order to exchange information concerning the current use of the code by the various organizations, EPRI and EI jointly sponsored a Second International RETRAN Meeting in San Diego, California on April 26-28, 1982. During the three-day meeting, 29 technical papers were presented by the various participants. The papers can be generally classified as: RETRAN development, verification and analysis of non-LWR systems; RETRAN analysis of PWRs; and RETRAN analysis of BWRS.

29643 (EPRI-NP—2494-SR, pp 1.iii-1.42) **RETRAN nonequilibrium two-phase flow model for operational transient analyses.** Paulsen, M.P.; Hughes, E.D. (Energy Inc., Idaho Falls, ID). Jul 1982. NTIS, PC A99/MF A01.

From 2. international RETRAN meeting; San Diego, CA, USA (28 Apr 1982).

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The field balance equations, flow-field models, and equation of state for a nonequilibrium two-phase flow model for RETRAN are given. The differential field balance model equations are: (1) conservation of mixture mass; (2) conservation of vapor mass; (3) balance of mixture momentum; (4) a dynamic-slip model for the velocity difference; and (5) conservation of mixture energy. The equation of state is formulated such that the liquid phase may be subcooled, saturated, or superheated. The vapor phase is constrained to be at the saturation state. The dynamic-slip model includes wall-to-phase and interphase momentum exchanges. A mechanistic vapor generation model is used to describe vapor production under bulk subcooling conditions. The speed of sound for the mixture under nonequilibrium conditions is obtained from the equation of state formulation. The steady-state and transient solution methods are described.

29644 (EPRI-NP—2494-SR, pp 2.iii-2.40) **Numerical solution method improvements for RETRAN.** Hughes, E.D.; Katsma, K.R. (Energy Inc., Idaho Falls, ID). Jul 1982. NTIS, PC A99/MF A01.

From 2. international RETRAN meeting; San Diego, CA, USA (28 Apr 1982).

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Several aspects of the numerical solution methods in RETRAN are investigated with the objective of improving or removing time-step size limitations. The investigations have focused on the material-transport Courant limit associated with the mixture energy equation. Numerical representation of all terms in the balance equations and the iterative equation-of-state solution are also discussed. The initial development efforts have been related to the homogeneous equilibrium mixture model of two-phase flow. Some of the resutls are applicable to the four- and five-equation models. The numerical solution method improvements are illustrated by calculations.

29645 (EPRI-NP—2494-SR, pp 3.iii-3.25) **RETRAN-02 comparison with Semiscale Test S-07-10B.** Farman, R.F.; Motloch, C.G. (Energy Inc., Idaho Falls, ID). Jul 1982. NTIS, PC A99/MF A01.

From 2. international RETRAN meeting; San Diego, CA, USA (28 Apr 1982).

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A calculation of a small break experiment, Semiscale Test S-07-10b, was made with RETRAN-02. The results of the calculation were compared with a representative sample of measured data from the experiment. In general, the hydraulic response calculated by RETRAN-02 agreed well with the experiment. Two areas where the comparison indicates a potential for model improvement are in break flow and countercurrent slip flow modeling.

29646 (EPRI-NP—2494-SR, pp 4.iii-4.39) **Analysis of LOFT experiments on RETRAN-01.** Olding, C. (United Kingdom Atomic Energy Authority, Winfrith, England). Jul 1982. NTIS, PC A99/MF A01.

From 2. international RETRAN meeting; San Diego, CA, USA (28 Apr 1982).

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The RETRAN validation studies described in the present paper were carried out at AEE Winfrith in support of a generic program of research into PWR safety. The validation is specifially associated with RETRAN-01 MOD002 and the version in current use at Winfrith incorporates certain local modifications and additions. Of these, only two are relevant to the present work, VIZ: the procedure for the calculation of critical flow has been changed in order to improve the accuracy of prediction in small-break cases; and the Homogeneous Equilibrium Model (HEM) has been added to the list of critical flow correlation options. The current validation program is based mainly on experiments conducted on the LOFT installation at the Idaho National Engineering Laboratory. While only the pressurized transients of the L6 series were considered initially, the L3-6 and L3-5 small break experiments were subsequently added. In order to eliminate effects arising from ad hoc modelling on RETRAN performance, a comprehensive LOFT model was established at the start of the program and this was used for all the cases studied.

29647 (EPRI-NP—2494-SR, pp 5.1-5.21) **RETRAN-02 calculations of operational transients in LOFT.** Miller, C.S.; Hentzen, R.D.; White, J.R. Jul 1982. NTIS, PC A99/MF A01.

From 2. international RETRAN meeting; San Diego, CA, USA (28 Apr 1982).

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This paper provides a discussion of RETRAN-02 posttest calculations of anticipated transient tests performed in the Loss-of-Fluid-Test (LOFT) facility. RETRAN-02 calculations are compared wtih experiment data from the anticipated transiet tests L6-1, L6-2, L6-3, L6-5, and L9-1 conducted in the LOFT facility in 1980 and 1981. These tests were, respectively, a loss of steam load, a loss of forced primary coolant flow, an excessive load increase, a loss of feedwater, and a loss of feedwater with a delayed scram combined with no auxiliary feedwater addition. Posttest analyses of the LOFT L6 test series and the L9-1 test were performed. The objective of analyzing these transients was to assess the basic capabiltiy of RETRAN-02 to calculate the range of phenomena observed in the experimental data.

29648 (EPRI-NP—2494-SR, pp 6.iii-6.19) **Safety analyses of the nuclear-powered ship Mutsu with RETRAN.** Naruko, Y.; Ishida, T.; Tanaka, Y.; Futamura, Y. Jul 1982. NTIS, PC A99/MF A01.

From 2. international RETRAN meeting; San Diego, CA, USA (28 Apr 1982).

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To provide a quantitative basis for the safety evaluation of the N.S. Mutsu, a number of safety analyses were performed in the course of reexamination. With respect to operational transient analyses, the RETRAN computer code was used to predict plant performances on the basis of postulated transient scenarios. The COBRA-IV computer code was also used to obtain a value of the minimum DNBR for each transient, which is necessary to predict detailed thermal-hydraulic performances in the core region of the reactor. In the present paper, the following three operational transients, which were calculated as a part of the safety analyses, are being dealt with: a complete loss of load without reactor scram; an excessive load increase incident, which is followed by a 30 percent stepwise load increase in the steam dump flow; and an accidental depressurization of the primary system, which is followed by a sudden full opening of the pressurizer spray valve. A Mutsu two-loop RETRAN model and simulation results were described. The

results being compared with those of land-based PWRs, the characteristic features of the Mutsu reactor were presented and the safety of the plant under the operational transient conditions was confirmed.

29649 (EPRI-NP—2494-SR, pp 7.1-7.26) **Winfrith studies of severe PWR pressurized faults.** Kinnersly, S.R. (United Kingdom Atomic Energy Authority, Winfrith, England). Jul 1982. NTIS, PC A99/MF A01.

From 2. international RETRAN meeting; San Diego, CA, USA (28 Apr 1982).

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As part of a generic program of research into PWR safety, calculations of a number of severe pressurized faults have been carried out at Winfrith using a locally modified version of RETRAN-01. Chief among these have been investigations into the loss of feedwater without turbine trip and loss of load anticipated transients without scram (ATWS) and the steam line break accident. Best estimate calculations and, in come cases, sensitivity studies have been carried out. This paper presents some important RETRAN results from these studies.

29650 (EPRI-NP—2494-SR, pp 8.1-8.16) **Prediction of GE-ATLAS transient boiling transition data using RETRAN-02/RETRAN-15F.** Ansari, A.F.; Beller, D.K.; Haque, Q.A.; Schultz, S.P.; Burns, K.J. Jul 1982. NTIS, PC A99/MF A01.

From 2. international RETRAN meeting; San Diego, CA, USA (28 Apr 1982).

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The steady-state operating limit for Boiling Water Reactors (BWR) is determined by calculating the transient change in critical power ratio (CPR). In order to determine the operating limit CPR, a method for calculating the ΔCPR during transients is needed. This paper describes how the RETRAN code was used as a tool in the evaluation of transient critical power ratios for determining the operating margin for BWRs. Since the RETRAN code does not contain a critical power calculation, the ΔCPR cannot be obtained directly from RETRAN. Therefore, a program TCPYA01 designed to evaluate transient CPR (and ΔCPR) based on the GEXL correlation using time-dependent conditions from RETRAN was used. The justification for using the RETRAN code is provided by predicting transient boiling transition data taken at GE-ATLAS loop facility. Results of the sensitivity studies performed on nodalization, void models, and time-step size are also provided.

29651 (EPRI-NP—2494-SR, pp 9.1-9.19) **RETRAN's role in the development of northeast utilities analytical capabilities.** Bonaca, M.; Gharakhani, A.; Sterner, R. Jul 1982. NTIS, PC A99/MF A01.

From 2. international RETRAN meeting; San Diego, CA, USA (28 Apr 1982).

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The experience of the past ten years has demonstrated an ever-increasing need by utilities operating nuclear power plants for reanalysis of those accidents that form the design basis of the operating plants. It is desirable to have adequate models in place for each operating plant, which are compliant with current requirements, consistent with the state of the art, independent of fuel characteristics, and continuously maintained and upgraded. This objective, so desirable yet unachievable by the utility industry until a few years ago, has been made possible by the advent of the new generation of powerful digital models today available to the nuclear industry. In the thermal-hydraulic area, digital computer programs such as RETRAN, RELAP 5, TRAC and THERMIT, just to name a few, provide a capability superior to anything available in the industry before. Their broad field of applicability already provides the industry with the capability of addressing any thermal-hydraulic area in support of the fuel cycle.

29652 (EPRI-NP—2494-SR, pp 10.1-10.28) **RETRAN-02 analysis of a steam generator tube break incident.** Chao, J. (Nuclear Safety Analysis Center, Palo Alto, CA); Chexal, B.; Layman, W.; Rautmann, D.; Peterson, C.; Atchison, J.; Hansen, B. Jul 1982. NTIS, PC A99/MF A01.

From 2. international RETRAN meeting; San Diego, CA, USA (28 Apr 1982).

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The Nuclear Safety Analysis Center with the cooperation of The Northern States Power Company, has made a thermal hydraulic analysis of a steam generator tube break incident that occurred at Prairie Island-1 on October 2, 1979. The analysis was performed using the reactor system thermal hydraulic computer code, RETRAN-02. The objectives of the effort were: to evaluate the capability of RETRAN-02 to analyze a steam generator tube break transient; to verify that the prediction of RETRAN-02 is consistent with actual plant behavior; to accurately establish when the break occurred; to develop the model that represents the steam generator tube break situation and serve as input to RETRAN-02; and to determine the discharge coefficient that will result in realistic prediction of choked flow from the break.

29653 (EPRI-NP—2494-SR, pp 11.iii-11.19) **RETRAN-02 analysis of AN0-2 tests.** Ranatza, S. (Middle South Services, New Orleans, LA). Jul 1982. NTIS, PC A99/MF A01.

From 2. international RETRAN meeting; San Diego, CA, USA (28 Apr 1982).

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During Arkansas Nuclear One - Unit 2 (AN0-2) initial power ascension, four system transient tests were conducted. The four tests were: (1) turbine trip from 98.2% power; (2) total loss of flow from 81% power; (3) a full length Control Element Assembly (CEA) drop from 49.4% power; and (4) a part length CEA drop from 49.2% power. In addition to their licensing function, these test provided data for the validation of reactor system transient codes like RETRAN. Middle South Services 9MSS) has undertaken a project to benchmark RETRAN-02 against these AN0-2 start-up tests. The priamry purpose of this project is to develop validated RETRAN-02 models of AN0-2 which predict well the measured data. For this immediate effort, a point kietics representation of the core is used. The project also includes a task to develop a RETRAN model employing one-dimensional core kinetics ad to compare calculations using this model with test results. This paper presents the analysis of the turbine trip test with a point kinetics core representation.

29654 (EPRI-NP—2494-SR, pp 12.iii-12.12) **RETRAN analyses for improving plant procedures and operator training.** Broughton, T.G.; Trikouros, N.G. (GPU Nuclear Corp., Parsippany, NJ). Jul 1982. NTIS, PC A99/MF A01.

From 2. international RETRAN meeting; San Diego, CA, USA (28 Apr 1982).

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Realistic simulations of plant performance have been used to supplement existing plant data or to provide data where non existed. The simulations may cover events with durations in hours and may be required to consider plant conditions includng actual core physics conditions, valve leakage and auxiliary steam loads. In addition, it should be possible for the simulation to account for operator interaction and provide the information operators would have available through plant instrumentation. This paper describes how RETRAN simulations have been used in the development of procedures and training materials. Procedure applications have included development and validation of general control philosophy and establishment of specific test conditions and setpoints. Training applications include development of materials for teaching general plant response, specific plant response during tests and analysis of plant performance.

29655 (EPRI-NP—2494-SR, pp 13.1-13.22) **RETRAN analysis of PWR small break LOCA.** Choe, W.G.; Matsui, Y. (Nippon Energy Inc., Tokyo, Japan). Jul 1982. NTIS, PC A99/MF A01.

From 2. international RETRAN meeting; San Diego, CA, USA (28 Apr 1982).

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This paper presents the results of a small break LOCA analysis with the EPRI released version of RETRAN-02. The analyzed plant is a four-loop-type Westinghouse pressurized water reactor with the rated power of 3427 MWt. Two steam generator secondary side models are tested. A multiple nodalization of the secondary side is used for the accurate timing of a reactor trip due to the steam generator low-low water level setpoint. A single-volume

model is attempted to utilize the local condition heat transfer model of RETRAN-02. A sensitivity study on natural circulation versus forced convection for the transient is also presented.

29656 (EPRI-NP—2494-SR, pp 14.1-14.19) **RETRAN-02 analysis of upper head cooling during controlled natural circulation cooldown of Yankee Nuclear Power Station.** Fujita, N.; Helrich, R.E.; Bergeron,P.A. (Yankee Atomic Electric Co., Framingham, MA). Jul 1982. NTIS, PC A99/MF A01.

From 2. international RETRAN meeting; San Diego, CA, USA (28 Apr 1982).

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RETRAN-02 is particularly well-suited for investigating the fluid conditions in the upper head during a natural circulation cooldown. The RETRAN input model was developed with four basic objectives: (1) accurate description of the upper head cooling mechanisms; (2) proper simulation of natural circulation; (3) respresentations of operator actions required to proceed from full-power to shutdown-cooling-system conditions using both automatic and manual controls; and (4) reduction of the computer cost of simulating this evolution of approximately 10-hour duration. The response of the upper head fluid temperature calculated by RETRAN was in close agreement with measured data obtained from a natural circulation cooldown experiment performed for the Connecticut Yankee Plant, whose design is very similar to the Yankee Nuclear Power Station.

29657 (EPRI-NP—2494-SR, pp 15.1-15.9) **Auxiliary Feedwater system performance calculations using RETRAN.** Wolfhope, N.P.; Smith, N.A. (Virginia Electric and Power Co., Richmond). Jul 1982. NTIS, PC A99/MF A01.

From 2. international RETRAN meeting; San Diego, CA, USA (28 Apr 1982).

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A good example of the use of RETRAN for a generic safety study is an assessment of the Surry Auxiliary Feedwater (AFW) capability performed in July 1981. The RETRAN studies were performed with a single-loop, nineteen volume model with a single node secondary side. The studies showed that the AFW flow delivered by one motor-driven AFW pump (about 350 gpm), the original design basis, is not adequate to prevent liquid relief from the pressurizer, but that the flow delivered by two motor-driven pumps (> 500 gpm) is adequate.

29658 (EPRI-NP—2494-SR, pp 16.1-16.12) **Analysis of steam-generator transients with RETRAN-02.** Ramsden, K.B.; Munshi, P. (Commonwealth Edison Co., Chicago, IL). Jul 1982. NTIS, PC A99/MF A01.

From 2. international RETRAN meeting; San Diego, CA, USA (28 Apr 1982).

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A series of analyses were performed to determine the sensitivity of steam generator nodalization patterns to secondary side transients in PWRs. The code utilized in this study was RETRAN 02/MOD001. The purpose of this study was to determine a nodalization scheme capable of accurately representing steam generator behavior in secondary side transients. Modelling methods using various numbers of nodes (1 to 7 volumes) represent the secondary side were utilized, comparisons were made, using both algebraic and dynamic slip options, and iterative numeric methods. The transients compared were load-change and turbine-trip events. The results of the study showed that RETRAN can adequately analyze steam generator behavior in PWR secondary side transients. The seven volume secondary model of the steam generator gave the best results and closest agreement to vendor predictions and operational observations.

29659 (EPRI-NP—2494-SR, pp 17.iii-17.16) **RETRAN-01/RETRAN-02 comparison calculations for PWR transients.** Christiano, J.V. (Middle South Services, New Orleans, LA). Jul 1982. NTIS, PC A99/MF A01.

From 2. international RETRAN meeting; San Diego, CA, USA (28 Apr 1982).

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The RETRAN computer code is used to predict the thermal hydraulic responses for a nuclear steam supply systems under transient operating conditions Middle South Services utilizes two issues of RETRAN, namely RETRAN-01/MOD2 and RETRAN-02/MOD1. Certain basic differences exist between each code issue. To determine the effect of these differences on code calculation, results obtained form each code issue employing the same boundry conditions and system model are compared. These results show that both code issues calculate similar system responses, however, the calculated primary system variables do differ. RETRAN-01 and RETRAN-02 employ different techniques to solve their non-equilibrium pressurizer models. These differences in solution techniques appear to be the source of the differences in the primary system variables.

29660 (EPRI-NP—2494-SR, pp 18.1-18.29) **LOFTRAN/RETRAN comparison calculations for a postulated loss of feedwater ATWS in the Sizewell B PWR.** Papez, K.L. (National Nuclear Corp., Leicester, England); Risher, D.H. Jul 1982. NTIS, PC A99/MF A01.

From 2. international RETRAN meeting; San Diego, CA, USA (28 Apr 1982).

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The Sizewell B PWR is being designed for the CEGB by the National Nuclear Corporation (NNC) with co-operative assistance as members of a joint project team from the CEGB, Westinghouse and Bechtel. Safety transient analyses are being performed by NNC using standard Westinghouse developed computer codes and methods, including the LOFTRAN computer code for intact circuit faults. For the UK PWR, Anticipated Transient Without Scram (ATWS) sequences are examined on a probabilistic basic using established UK risk methods, reliabiltiy criteria and goals which in some cases differ substantially from US methods. Code and model variants used in this initial exploratory study and comparison of the LOFTRAN and RETRAN codes are given followed by a description of the particular ATWS transient, input data used and results obtained.

29661 (EPRI-NP—2494-SR, pp 19.1-19.41) **Qualification of a RETRAN-02 model for BWR transient analysis.** Garrett, M.E.; Forkner, S.L.; Keys, T.A.; Perry, G.W.; Waddell, M.W. Jul 1982. NTIS, PC A99/MF A01.

From 2. international RETRAN meeting; San Diego, CA, USA (28 Apr 1982).

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The Tennessee Valley Authority (TVA) is currently developing methods and procedures for performing reload core design and analysis (RCDA). This RCDA methodology will first be used in the design and licensing of Browns Ferry (BFN) unit 3, reload 5, scheduled for startup early in 1984. An important step in developing RCDA capabilities is the qualification of a system transient model for use in analyses to support reload core licensing. Qualification work is being performed at TVA for a BFN transient analysis model based on the RETRAN-02 computer code. This paper describes the first part of the qualification work performed in support of the BFN RETRAN model.

29662 (EPRI-NP—2494-SR, pp 20.1-20.35) **BWR stability analysis with RETRAN.** Hornyik, K. (Oregon State Univ., Corvallis). Jul 1982. NTIS, PC A99/MF A01.

From 2. international RETRAN meeting; San Diego, CA, USA (28 Apr 1982).

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A RETRAN model was developed for determining the stability of BWRs operating with high power/flow ratios. This model was applied to Peach Bottom 2 and compared with the stability tests conducted at the end of fuel cycle 2. Because of the deterministic nature of the RETRAN model it appears logical to select those where pseduo-random switching was employed. Comparisons were made both in the time domaine and the frequency domaine between the computed equilibrium cycle and a measured equilibrium cycle obtained as an average over a large number of cycles. The variables of interest are the system pressure measured in the steam dome and the average neutron flux measured by an APRM.

29663 (EPRI-NP—2494-SR, pp 21.iii-21.19) **RETRAN-01/-02 analysis of a dual recirculation pump trip transient in a 2436-MWt BWR/4 plant.** Alapour, A.; Surjanto, T.B. Jul 1982. NTIS, PC A99/MF A01.

From 2. international RETRAN meeting; San Diego, CA, USA (28 Apr 1982).

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RETRAN-01/RETRAN-02 were used to analyze the actual plant transient data recorded during a dual recirculation pump trip test in a 2436-MWt BWR/4 plant. Analysis of the plant transient data indicates that the agreement between measured and calculated parameters is remarkably close. A discussion of the differences between RETRAN-01 and RETRAN-02 (with 01 options) calculations is presented in this paper, which verifies RETRAN-02's overall performance in this transient. Also discussed in this paper is the indication that the observed disagreements between measured and calculated parameters are attributed to the small magnitude of the void reactivity coefficient used implicitly in RETRAN, the inadequacies in determining the hydraulic resistances in the recirculation loops, the inherent approximate nature of analytical models associated with 01 options, and the uncertainties in the measured quantities.

29664 (EPRI-NP—2494-SR, pp 22.1-22.20) **Realistic assessment on anticipated transient without scram for WNP-2 nuclear plant.** Wang, O.S. (Washington Public Power Supply System, Richland). Jul 1982. NTIS, PC A99/MF A01.

From 2. international RETRAN meeting; San Diego, CA, USA (28 Apr 1982).

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In order to assess the adequacy of the existing ATWS (Anticipated Transient Without Scram) mitigating systems, efforts have been made toward a realistic safety evaluation of the existing Standby Liquid Control System 9SLCS) and other mitigating systems for the Washington Public Power Supply System's (the Supply System) Nuclear Project no. 2 (WNP-2). The consequence of ATWS for light water reactors has been a subject of continuing controversy since its publication WASH-1270. To ensure safe operation of the plant, the Supply System has performed a rather realistic assessment using the RETRAN code and other methods to evaluate the capability of the existing ATWS mitigating systems. The specific transient selected for this study was turbine trip without bypass (TTWOB) which was the limiting ATWS event as far as the vessel pressurization, power excursion and containment response were concerned. This realistic evaluation demonstrated that the existing WNP-2 design coupled with BWR'S inherent strong void feedback and proper operator training was able to prevent potential adverse consequences of any hpothetical ATWS event.

29665 (EPRI-NP—2494-SR, pp 23.1-23.9) **Suppression pool temperature transient analysis with RETRAN-01.** Munshi, P. (Commonwealth Edison Co., Chicago, IL); Domashovetz, I. Jul 1982. NTIS, PC A99/MF A01.

From 2. international RETRAN meeting; San Diego, CA, USA (28 Apr 1982).

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An analysis was performed to determine the suppression pool temperature behavior during the course of a small steam line break accident with main steam isolation and scram in a BWR/5. The code used in this study was RETRAN-01/MOD002. The purpose of the analysis was to determine if RETRAN could be utilized to perform suppression pool temperature transient analysis, and to observe the amount of computer time required to perform this calculation.

29666 (EPRI-NP—2494-SR, pp 24.1-24.22) **Peach Bottom analysis using various RETRAN-02 options.** Naser, J.A. Jul 1982. NTIS, PC A99/MF A01.

From 2. international RETRAN meeting; San Diego, CA, USA (28 Apr 1982).

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The Peach Bottom Atomic Power Station Unit 2 is a BWR/4 with a rated thermal power output of 3293 MW, a rated core flow of 102.5 x 10^6 lb/h, and a rated steam flow of 13.37 x 10^6 lb/h at a turbie inlet pressure of 965 psia. The three turbine trip tests were performed at the end of cycle tow during April, 1977. In this study only Turbine Trip (TT2) will be used to explore the effects of the new capabilities in RETRAN-02. In addition, a calculation has been made using the experimental five-equation version of RETRAN. As the first step in this analysis, a RETRAN-01 calculation was performed to compare with a RETRAN-02 calculation using only options available in RETRAN-01. A comparison of these two calculations will give an indication of the effects of the new water property functional fits and calculational strategies in RETRAN-02. The new RETRAN-02 models explored in this study will be dynamic slip, algebraic slip, subcooled void profile fit, single and double region special steam separators, one-dimensional kinetics, and iterative numerics. The use of the nonequilibrium pressurizer model for the upper downcomer region will also be studied.

29667 (EPRI-NP—2494-SR, pp 25.iii-25.18) **Exact analytic technique for three-dimensional to one-dimensional cross section collapsing.** Holzer, J.M. Jul 1982. NTIS, PC A99/MF A01.

From 2. international RETRAN meeting; San Diego, CA, USA (28 Apr 1982).

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Yankee Atomic Electric company has developed a methodology for generating one-dimensional cross section sets for utilization in reduced core simulation. The methodology, termed the Exact Analytic Technique, is unique in its objective and approach. First, the calculated three-dimensional quantities that are desired to be preserved are specified. Then, analytic expressions that achieve this objective are developed. The statement of objective and the development of the Exact Analytic Technique are presented in this paper.

29668 (EPRI-NP—2494-SR, pp 26.1-26.12) **Investigation of the one-dimensional reactor kinetics model in RETRAN-02 MOD-002.** Miller, J.G. (Virginia Electric and Power Co., Richmond). Jul 1982. NTIS, PC A99/MF A01.

From 2. international RETRAN meeting; San Diego, CA, USA (28 Apr 1982).

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Virgiia Electric and Power Company (Vepco) is investigating the capability of the one-dimensional (1-D) kinetics option of the RETRAN-02 code as applied to the modelig of PWR transients. An in-house interface code, AXTRN, as been written in order to create the nuclear cross section library required by the RETRAN 1-D kinetics option from cross section data provided by the Vepco ATOM1 1-D, steady state diffusion code. Calculational results for the postulated rod ejection transient are presented along with a comparison to NSSS vendor FSAR prediction.

29669 (EPRI-NP—2494-SR, pp 28.iii-28.15) **Analysis of load rejection transient in a 2436MWt BWR/4 plant with RETRAN-01/02.** Surjanto, T.B.; Alapour, A. (Southern Co. Services, Inc., Birmingham, AL). Jul 1982. NTIS, PC A99/MF A01.

From 2. international RETRAN meeting; San Diego, CA, USA (28 Apr 1982).

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RETRAN-01/RETRAN-02 were used to analyze the actual plant transient data recorded during a load rejection test in a 2436-MWt BWR/4 plant. Analysis of the plant transient data indicates that the agreement between measured and calculated parameters is remarkably close. A discussion of the differences between RETRAN-01 and RETRAN-02 (with 01 options) calculations is presented in this paper, which verifies RETRAN-02's overall performance in this transient despite a ~ 30 Btu/1bm under prediction of calculated enthalpy (by RETRAN-02) at the end of steam line junction. Also discussed in this paper is the indication that the observed disagreements between measured and calculated parameters are attributed to the inappropriate use of scram time delay used in the model, the inadequacies in determining the hydraulic resistances in the recirculation loops, the inherent approximate nature of analytical models associated with 01 options, accuracy in the feedwater control system model, and the uncertainties in the measured quantities.

29670 (EPRI-NP—2709-CCM-Vol.3) **ABAQUS-EPGEN: a general-purpose finite element code. Volume 3. Example problems manual.** Hibbitt, H.D.; Karlsson, B.I.; Sorensen, E.P. (Hibbitt, Karlsson and Sorensen, Providence, RI (USA)). Mar 1983. 579p. NTIS, PC A25/MF A01. Order Number DE83901898.

This volume is the Example and Verification Problems Manual for ABAQUS/EPGEN. Companion volumes are the User's, Theory and Systems Manuals. This volume contains two major parts. The bulk of the manual (Sections 1-8) contains worked examples that are discussed in detail, while Appendix A documents a large set of basic verification cases that provide the fundamental check of the elements in the code. The examples in Sections 1-8 illustrate and verify significant aspects of the program's capability. Most of these problems provide verification, but they have also been chosen to allow discussion of modeling and analysis techniques. Appendix A contains basic verification cases. Each of these cases verifies one element in the program's library. The verification consists of applying all possible load or flux types (including thermal loading of stress elements), and all possible foundation or film/radiation conditions, and checking the resulting force and stress solutions or flux and temperature results. This manual provides program verification. All of the problems described in the manual are run and the results checked, for each release of the program, and these verification results are made available.

29671 **(EPRI-NP—2747) Scale-model tests of turbine missile containment by reinforced concrete. Final report.** Romander, C.M.; Florence, A.L. (SRI International, Menlo Park, CA (USA)). Mar 1983. 201p. NTIS, PC A10/MF A01. Order Number DE83901977.

Twenty-five impact tests were performed on 1/11-scale models of reinforced-concrete walls. The objective of these tests was to determine experimentally the threshold velocity at which postulated turbine missiles perforate reinforced-concrete walls, such as the containment structures and auxiliary plant structures, found in typical presurized-water-reactor (PWR) plants. Four scale model reinforced-concrete targets and three scale-model turbine missiles were used in the tests. The four targets represent 4.5- and 3.5-ft-thick, heavily reinforced containment walls with steel liners; a 3-ft-thick, lightly reinforced containment wall backed up by a separate steel plate; and a 2-ft-thick, lightly reinforced control room wall. The three 1/11-scale turbine missiles model a 3250-lb missile, a 4000-lb missile, and an 8300-lb missile. The missiles were propelled at velocities from 130 ft/s up to 700 ft/s to strike the target in a piercing orientation (sharp edge impacting), a blunt orientation (broad edge impacting), and a glancing-blow orientation (piercing orientation at 45° to the target). Test results are presented.

29672 **(EPRI-NP—2820) Two-phase-flow characteristics during reflooding of a hot vertical tube. Final report.** Kawaji, M.; Banerjee, S. (California Univ., Santa Barbara (USA). Dept. of Chemical and Nuclear Engineering). Mar 1983. 68p. NTIS, PC A05/MF A01. Order Number DE83901900.

Experiments have been performed to measure transient void fraction histories during reflooding of a hot vertical tube. This report describes the constant-injection bottom-reflood experimental program and its results, including void fraction measurements made with a gamma densitometer. These data show different void fraction profiles for the two flow regimes observed at the quench front - inverted-annular and annular flow.

29673 **(EPRI-NP—2935) Thermal mixing in a model cold leg and downcomer at low flow rates.** Rothe, P.H.; Fanning, M.W. (Creare, Inc., Hanover, NH (USA)). Mar 1983. 480p. NTIS, PC A21/MF A01. Order Number DE83901946.

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This report describes an experimental program of fluid-mixing experiments performed at atmospheric pressure in a 1/5-scale, transparent model of a cold leg and downcomer typical of Combustion Engineering and Westinghouse Pressurized Water Reactors (PWRs). The test program simulated steady-state conditions thought to be extreme for small break Loss of Coolant Accidents (LOCAs). Analysis of transient and steady-state temperature records indicates that the cold High-Pressure Injection (HPI) coolant water and the hot primary coolant water are well mixed prior to flowing over the reactor vessel wall.

29674 **(GEND—032) TMI-2 Technical Information and Examination Program. 1982 annual report.** (EG and G Idaho, Inc., Idaho Falls (USA)). Apr 1983. Contract AC07-76ID01570. 97p. NTIS, PC A05/MF A01. Order Number DE83010177.

The Department of Energy's Technical Information and Examination Program at Three Mile Island Unit 2 continued the research and development work begun on the island in 1980. The work concentrated in seven major areas: instrumentation and electrical components, radiation and environment, core activities, information and industry coordination, configuration and document control, waste immobilization, and reactor evaluation. The program assists in resolving specific problems at TMI-2 while developing techniques and broadening understanding of accident consequences to improve the overall safety and reliability of nuclear power. The Technical Information and Examination Program aims to communicate applicable information to the nuclear power industry to ensure that the industry can avail itself of the maximum amount of information possible.

29675 **(JAERI-M—9624) Multi-rod burst test under a loss-of-coolant accident condition, (2). Experimental result of the bundle No.7806.** Otomo, T.; Hashimoto, M.; Kawasaki, S.; Furuta, T.; Uetsuka, H. (Japan Atomic Energy Research Inst., Tokyo). Aug 1981. 60p. (In Japanese). NTIS (US Sales Only), PC A04/MF A01. Order Number DE83701498.

Multi-rod burst test No. 7806 was performed with a views to estimating the quantitative channel blockage caused by the ballooning of fuel assembly during a postulated LOCA. The test was conducted under conditions of initial internal pressure 20 kg/cm², steam flow rate 0.4 g/cm²min and heating rate 9°C/sec. Following results were obtained: (1) Internal pressure increased up to 28 kg/cm² during the heat-up stage, the average burst pressure of 49 rods being measured to be about 26 kg/cm². (2) Almost all ruptured claddings had relatively short ballooned region length expanded above 34%. The length ranged from 0 to 40 mm, being much shorter than those measured in other tests performed under different conditions. (3) Maximum channel blockage of the assembly(7 x 7) was measured to be 36.2%, while was 43.4% in the interior rods(5 x 5) which had relatively uniform temperature distribution in the radial direction of the rod. These values were also smaller than those measured in other tests.

29676 **(JAERI-M—9699) Engineering data of seamate:II, 2. Test on the characteristics of temperature regulation in the pressure vessel.** Tanaka, S.; Okada, S.; Ito, M.; Kusama, Y.; Yoshida, K.; Nakase, Y. (Japan Atomic Energy Research Inst., Tokyo). Sep 1981. 59p. (In Japanese). NTIS (US Sales Only), PC A04/MF A01. Order Number DE83701543.

SEAMATE-II (Simulated Environmental Apparatus for Material Testing) was constructed in order to establish methodologies for the test of electrical cables under the conditions of postulated LOCA including radiation, and to provide the engineering data for designing the qualification testing facility. A part of engineering data have been previously reported on rapid heating of the inside of the pressure vessel with its outlet valve closed. The engineering data reported here are as follows, 1) controllability of the control devices at rapid heating, 2) comparison of the temperature control systems based on temperature detection, pressure detection and temperature converted from detected pressure, 3) controllability of the automatic control system during rapid heating and rapid cooling, 4) quantities of steam and cooling water required for the automatic control.

29677 **(JAERI-M—9710) Estimation of fuel temperature increase during coolant boiloff accident.** Abe, K. (Japan Atomic Energy Research Inst., Tokyo). Oct 1981. 46p. (In Japanese). NTIS (US Sales Only), PC A03/MF A01. Order Number DE83701521.

Fuel rod temperature increase during coolant boiloff accident due to unavailable ECCS was analyzed using a simple time dependent model. A standard case was first selected and its results clarified how is the fuel temperature behavior during the boiloff accident. Then the sensitivity studies for various parameters were performed to know what parameters have important roles. As a result of analyses, it was shown that the coolant mixture level in the core has a dominant effect on the core heatup and that fuel rod claddings will probably slump or melt before its full oxidation.

29678 **(KFK—3416-B) Comparison of thermal behavior of different PWR fuel rod simulators for LOCA experiments.** Casal, V.; Malang, S.; Rust, K. (Kernforschungszentrum Karlsruhe G.m.b.H. (Germany, F.R.). Inst. fuer Reaktorbauelemente; Kernforschungszentrum Karlsruhe G.m.b.H. (Germany, F.R.). Projekt Nukleare Sicherheit). Oct 1982. 2p. NTIS (US Sales Only), PC A02/MF A01. Order Number DE83750313.

For experimental investigations of a loss-of-coolant accident (LOCA) of a PWR electrical heater rods are applied as thermal fuel rod simulators. To substitute heater rods from the SEMISCALE program by INTERATOM-KfK heater rods in a current experimental program at the Instituut for Energiteknikk-(OECD-Halden), the thermodynamic behavior of different heater rods during a LOCA were compared. The results show, that SEMISCALE-heater rods can be replaced by those fabricated by INTERATOM.

29679 **(NUREG—0827) Integrated plant safety assessment: Systematic Evaluation Program. LaCrosse Boiling Water Reactor, Dairyland Power Cooperative, Docket No. 50-409.** (Nuclear Regulatory Commission, Washington, DC (USA). Office of Nuclear Reactor Regulation). Apr 1983. 491p. NTIS, PC A21/MF A01 - GPO. Order Number DE83901962.

The Systematic Evaluation Program was initiated in February 1977 by the US Nuclear Regulatory Commission to review the designs of older operating nuclear reactor plants to confirm and document their safety. The review provides: (1) an assessment of how these plants compare with current licensing safety requirements relating to selected issues, (2) a basis for deciding on how these differences should be resolved in an integrated plant review, and (3) a documented evaluation of plant safety. This report documents the review of the La Crosse Boiling Water Reactor, operated by Dairyland Power Cooperative. The La Crosse plant is one of 10 plants reviewed under Phase II of this program. This report indicates how 137 topics selected for review under Phase I of the program were addresed. Equipment and procedural changes have been identified as a result of the review.

29680 **(NUREG—0961) Long-range research plan, FY 1984-FY 1988.** (Nuclear Regulatory Commission, Washington, DC (USA). Office of Nuclear Regulatory Research). Apr 1983. 197p. NTIS, PC A09/MF A01 - GPO $7.00. Order Number DE83901634.

Development of the Long-Range Research Plan (LRRP) is the first step in the process of ensuring that the Nuclear Regulatory Commission's research program is directed toward areas of importance to the regulatory program. The LRRP is intended to assist the Commission in establishing priorities to ensure effective utilization of limited resources. It identifies broad regulatory issues and describes programmatic approaches for research to support the resolution of these issues over a 5-year period. Some of these broad issues are designated as Unresolved Safety Issues or TMI Action Plan Items. Areas of research include: plant aging; pressurized thermal shock; equipment qualification; severe accidents; thermal-hydraulic transients; advanced reactors; risk analysis; human factors; instrumentation and control; external events; radiation protection and health effects; and waste management.

29681 **(NUREG—0979) Safety Evaluation Report related to the final design approval of the GESSAR II BWR/6 Nuclear Island design, Docket No. 50-447.** (Nuclear Regulatory Commission, Washington, DC (USA). Office of Nuclear Reactor Regulation). Apr 1983. 455p. NTIS, PC A20/MF A01 - GPO $11.00. Order Number DE83901662.

The Safety Evaluation Report for the application filed by General Electric Company for the Final Design Approval for the General Electric Standard Safety Analysis Report (GESSAR II FSAR) has been prepared by the Office of Nuclear Reactor Regulation of the Nuclear Regulatory Commission. This report summarizes the results of the staff's safety review of the GESSAR II BWR/6 Nuclear Island Design. Subject to favorable resolution of items discussed in the Safety Evaluation Report, the staff concludes that the facilities referencing GESSAR II, subject to approval of the balance-of-plant design, can conform with the provisions of the Act and the regulations of the Nuclear Regulatory Commission.

29682 **(NUREG/CP—0035) 1981 NRC/BNL/IEEE standards workshop on human factors and nuclear safety. The man-machine interface and human reliability: an assessment and projection.** Hall, R.E.; Fragola, J.R.; Luckas, W.J. Jr. (eds.). (Institute of Electrical and Electronics Engineers, Inc., New York (USA)). Sep 1981. Contract AC02-76CH00016. 264p. (BNL-NUREG—51579; CONF-8108153—). NTIS, PC E10/MF A01 - GPO. Order Number DE83009326.

From NRC-BNL-IEEE standards workshop on human factors and nuclear safety - the man-machine interface and human reliability: an assessment and projection; Myrtle Beach, SC, USA (30 Aug 1981).

Includes 3 sheets of 24x reduction microfiche.

The role of the human in the safety of nuclear power plant operations was addressed in a meeting held in Myrtle Beach, SC in August 1981. Presentation were made on Control Room reviews, safety parameter display systems, the integration of human factors in the entire design process, and the use of automated control features. A need was shown for the development of a taxonomy or model to structure future data gathering and the need for models and data to address the issue of cognitive behavior. The primary effect of this behavior on risk was identified. Discussion sessions on the human impact on reliability, and control room design and evaluation were included. (ACR)

29683 **(NUREG/CR—2000-Vol.2-No.3) Licensee Event Report (LER) compilation: for month of March 1983.** (Oak Ridge National Lab., TN (USA)). Apr 1983. Contract W-7405-ENG-26. 119p. (ORNL/NSIC—200-Vol.2-No.3). NTIS, PC A06/MF A01 - GPO. Order Number DE83010788.

This monthly report contains Licensee Event Report (LER) operational information that was processed into the LER data file of the Nuclear Safety Information Center (NSIC) during the one month period identified on the cover of the document. The LERs, from which this information is derived, are submitted to the Nuclear Regulatory Commission (NRC) by nuclear power plant licensees in accordance with federal regulations. The LER summaries in this report are arranged alphabetically by facility name and then chronologically by event date for each facility. Component, system, and keyword indexes follow the summaries.

29684 **(NUREG/CR—2331-Vol.2-No.3) Safety research programs sponsored by Office of Nuclear Regulatory Research. Quarterly progress report, July 1-September 30, 1982.** Weiss, A.J. (comp.). (Brookhaven National Lab., Upton, NY (USA)). Jan 1983. Contract AC02-76CH00016. 161p. (BNL-NUREG—51454-Vol.2-No.3). NTIS, PC A08/MF A01 - GPO. Order Number DE83010333.

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The projects reported are the following: HTGR Safety Evaluation, SSC Development, Validation and Application, Generic Balance of Plant Modeling, Thermal-Hydraulic LWR and LMFBR Safety Experiments, LWR Plant Analyzer Development, LWR Code Assessment and Application; Stress Corrosion Cracking of PWR Steam Generator Tubing, Standards for Materials Integrity in LWRs, Probability Based Load Combinations for Structural Design, Mechanical Piping Benchmark Problems, Soil Structure Interaction; Human Error Rate Data Analysis and Criteria on Human Engineering Regulatory Guides. The previous reports have covered the period October 1, 1976 through June 30, 1982.

29685 **(NUREG/CR—2528) LOCA simulation in the National Research Universal reactor program: data report for the third materials experiment (MT-3).** Mohr, C.L.; Hesson, G.M.; King, L.L. (Pacific Northwest Lab., Richland, WA (USA)). Apr 1983. Contract AC06-76RL01830. 218p. (PNL—4166). NTIS (US Sales Only), PC A10/MF A01 - GPO $7.50.

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A series of in-reactor experiments are being conducted using full-length 32-rod pressurized water reactor (PWR) fuel bundles as part of the Loss-of-Coolant Accident (LOCA) Simulation Program by Pacific Northwest Laboratory (PNL). The third materials experiment (MT-3) is described. The 12 test rods in the center of the

32-rod bundle were initially pressurized to 3.8 MPa (550 psi) to insure rupture in the correct temperature range. All 12 of the test rods ruptured with an average peak bundle strain of 55.4%. Experimental data for the transient experiment and post-test measurements and photographs of the fuel are presented in this report.

29686 **(NUREG/CR—2530) Review of the Grand Gulf Hydrogen Igniter System.** Cummings, J.C.; Camp, A.L.; Sherman, M.P.; Wester, M.J.; Tomasko, D.; Byers, R.K.; Burnham, B.W. (Sandia National Labs., Albuquerque, NM (USA)). Mar 1983. Contract AC04-76DP00789. 225p. (SAND—82-0218). NTIS, PC A10/MF A01 - GPO $8.50. Order Number DE83010808.

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The Mississippi Power and Light Company has proposed installation of a Hydrogen Igniter System (HIS) at the Grand Gulf Nuclear Station (BWR Mark III) to burn hydrogen generated during accidents more severe than the design-basis accidents. Sandia National laboratories, under a contract with the US Nuclear Regulatory Commission, has performed a technical evaluation of the adequacy of the proposed HIS to meet the threat posed by hydrogen combustion. Areas considered in this review include: HIS design and testing; location and distribution of igniters; containment pressure and temperature response calculations; detonations; containment atmosphere mixing mechanisms; actuation criteria for the HIS; and the spectrum of hydrogen-generating accidents.

29687 **(NUREG/CR—2774-Vol.4) Physics of reactor safety. Quarterly report, October-December 1982.** (Argonne National Lab., IL (USA)). Feb 1983. Contract W-31-109-ENG-38. 29p. (ANL—82-24-Vol.4). NTIS, PC A03/MF A01 - GPO. Order Number DE83010607.

This Quarterly progress report summarizes work done during the months of October-December 1982 in Argonne National Laboratory's Applied Physics and Components Technology Divisions for the Division of Reactor Safety Research of the US Nuclear Regulatory Commission. The work in the Applied Physics Division includes reports on reactor safety modeling and assessment by members of the Reactor Safety Appraisals Section. Work on reactor core thermal-hydraulics is performed in ANL's Components Technology Division, emphasizing 3-dimensional code development for LMFBR accidents under natural convection conditions. An executive summary is provided including a statement of the findings and recommendations of the report.

29688 **(NUREG/CR—2809-Vol.4) Aerosol release and transport program. Quarterly progress report, October-December 1982.** Adams, R.E.; Tobias, M.L. (Oak Ridge National Lab., TN (USA)). May 1983. Contract W-7405-ENG-26. 34p. (ORNL/TM—8397/V4). NTIS, PC A03/MF A01. Order Number DE83010785.

The Aerosol Release and Transport Program at Oak Ridge National Laboratory (ORNL) is designed to investigate the release, transport, and behavior of aerosols that may carry radionuclides originating from a severe accident resulting in core melting. Aspects of the program apply to both light-water reactors (LWRs) and liquid-metal fast breeder reactors. The experimental programs are being conducted in the Fuel Aerosol Simulant Test (FAST) Facility (which also includes the CRI-III vessel), the NSPP Facility, and the CRI-II Facility. The analytical efforts are designed to support the experiments and to provide an independent assessment of the safety margins that exist for the estimation of the radiological consequences of a core meltdown accident.

29689 **(NUREG/CR—2853) Non-condensible gas fraction predictions using wet and dry bulb temperature measurements.** Bowman, J.; Griffith, P. (Massachusetts Inst. of Tech., Cambridge (USA). Dept. of Mechanical Engineering). Mar 1983. 161p. NTIS, PC A08/MF A01 - GPO $6.50. Order Number DE83901809.

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A technique is presented whereby non-condensible gas mass fractions in a closed system can be determined using wet bulb and dry bulb temperature and system pressure measurements. This technique would have application in situations where sampling techniques could not be used. Using an energy balance about the wet bulb wick, and expression is obtained which relates the vapor concentration difference between the wet bulb wick and the free stream to the wet and dry bulb temperature difference and a heat to mass transfer coefficient ratio. This coefficient ratio was examined for forced and natural convection flows. This analysis was verified with forced and natural convection tests over the range of pressure and temperature from 50 to 557 psig and 415 to 576°F. All the data could best be fit by the natural convection analysis. This is useful when no information about the flow field is known.

29690 **(NUREG/CR—2913-Rev.4) Two-phase jet loads.** Weigand, G.G.; Thompson, S.L.; Tomasko, D. (Sandia National Labs., Albuquerque, NM (USA)). Jan 1983. Contract AC04-76DP00789. 292p. (SAND—82-1935-Rev.4). NTIS, PC A13/MF A01. Order Number DE83010239.

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A model has been developed for predicting two-phase, water jet loadings on axisymmetric targets. The model ranges in application from 60 to 170 bars pressure and 70°C subcooled liquid for 0.75 (or greater) quality - completely covering the range of interest in pressurized water or boiling water reactors. The model was developed using advanced two-dimensional computational techniques to solve the governing equations of mass, momentum, and energy. The model displays in a series of tables and charts the target loa. and pressure distributions as a function of vessel (or break) conditions; this enables fast yet accurate look up for answers. For many situations of practical interest, the model can predict subcooled and saturated loadings in excess of the simple control volume upper bounds of $2P_0A$/sub e/ for nonflashing liquid and 1.26 P_0A/sub e/ for steam.

29691 **(NUREG/CR—3141) Characterization of two-phase flow using neutronic fluctuations.** Albrecht, R.W.; Crowe, R.D.; Dailey, D.J.; Kosaly, G.; Sanchez, R. (Washington Univ., Seattle (USA). Dept. of Nuclear Engineering). Mar 1983. 327p. NTIS, PC A15/MF A01 - GPO $9.00. Order Number DE83901640.

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The characterizatoin of two-phase flow in a nuclear reactor is of significance for both operational and safety reasons. This study reports on the exploration of flow-regime characterization by using measurements of the neutron-flux fluctuations induced by the two-phase flow passing through a nuclear-reactor core. It is shown that many significant properties of the flow can be determined by analysis of the induced neutronic fluctuations. These characteristics have been categorized as propagation, structure, and dynamics of the flow. In order to carry out this investigation, it was necessary to develop models for the response of the neutron field to flow perturbations and to relate measured flow quantities to phenomenological models of the flow. These modelling activities are summarized in this report. The experimental program of two-phase-flow characterization was carried out using an air/water loop in the University of Washington Nuclear Reactor (UWNR) and a parallel loop for visual studies. Details of the construction of the apparatus are summarized.

29692 **(NUREG/CR—3149) Dispersion coefficients for coastal regions.** MacRae, B.L.; Kaleel, R.J.; Shearer, D.L. (TRC Environmental Consultants, Inc., Englewood, CO (USA)). Mar 1983. Contract AC06-76RL01830. 52p. (PNL—4627). NTIS, PC A04/MF A01 - GPO $4.75. Order Number DE83010376.

The Nuclear Regulatory Commission (NRC) has undertaken an extensive atmospheric dispersion research and measurement program from which it is intended will emerge improved predictive techniques for employment in licensing decisions and for emergency planning and response. Through this program the NRC has conducted field measurement programs over a wide range of geographic and topographic locations, and are using the acquired tracer and meteorological measurements to evaluate existing dispersion models and prediction techniques, and to develop new techniques when necessary.

29693 (NUREG/CR—3157) Design of reinforced-concrete containment-wall elements under combined action of shear and tension. Calvo, J.; Buyukozturk, O.; Connor, J.J. (Massachusetts Inst. of Tech., Cambridge (USA). Dept. of Civil Engineering). Feb 1983. 225p. NTIS, PC A10/MF A01 - GPO $7.50. Order Number DE83901841.

Behavioral models are developed for reinforced concrete containment wall panels having orthogonal reinforcement and for those having both orthogonal and diagonal reinforcement. An initial axial tension which causes cracking in the concrete, is applied to the orthogonal reinforcement to simulate the normal membrane stresses induced by an accidental internal pressure load. This load is followed by the application of cyclic membrane shear histories representing the tangential shear stresses generated in the event of an earthquake. Using these two models, the experimentally measured strengths of various specimens are evaluated in view of important behavioral parameters. Then, an equation in terms of the governing parameters is proposed to predict the ultimate strength of these panels. Finally, a practical design produced is developed and recommended as a replacment for the design criteria specified by the current Code.

29694 (ORNL/TM—8297) Common cause evaluations in applied risk analysis of nuclear power plants. Taniguchi, T.; Ligon, D.; Stamatelatos, M. (Oak Ridge National Lab., TN (USA)). Apr 1983. Contract W-7405-ENG-26. 199p. NTIS, PC A09/MF A01. Order Number DE83010401.

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Qualitative and quantitative approaches were developed for the evaluation of common cause failures (CCFs) in nuclear power plants and were applied to the analysis of the auxiliary feedwater systems of several pressurized water reactors (PWRs). Key CCF variables were identified through a survey of experts in the field and a review of failure experience in operating PWRs. These variables were classified into categories of high, medium, and low defense against a CCF. Based on the results, a checklist was developed for analyzing CCFs of systems. Several known techniques for quantifying CCFs were also reviewed. The information provided valuable insights in the development of a new model for estimating CCF probabilities, which is an extension of and improvement over the Beta Factor method. As applied to the analysis of the PWR auxiliary feedwater systems, the method yielded much more realistic values than the original Beta Factor method for a one-out-of-three system.

29695 Doses received while crossing a plume of radioactive material released during an accident at a nuclear power plant. Scherpelz, R.I.; Desrosiers, A.E. (Pacific Northwest Lab., Richland, WA (USA)). *Health Physics;* **43**: No. 2, 187-203(Aug 1982).

A set of calculations was performed to determine doses resulting from a release of radioactive material during a hypothetical serious accident at a nuclear power plant. Three different accident scenarios were considered, and calculations were performed for each of three meteorological conditions accompanying each accident scenario. The calculated doses were the doses received by a reference man traversing the entire width of the plume of radioactive material at distances ranging from one to 40 km downwind of the release site. Dose pathways considered included the internal dose due to inhalation of material in the plume, the external dose due to exposure to the plume, and the external dose due to ground contamination deposited by the passing plume. The calculated doses are presented along with a discussion of their implications for emergency response planning.

29696 Seismic risk analysis and decisions for nuclear power plants. Smith, P.D. (California Univ., Livermore (USA). Lawrence Livermore National Lab.). *Nuclear Engineering and Design;* **71**: No. 3, 431-432(Aug 1982).

Presented at the 3. international seminar on the reliability of nuclear power plants.

Seismic risk analysis and associated sensitivity studies constitute a part of the Seismic Safety Margins Research Program being conducted by the Lawrence Livermore National Laboratory for the US Nuclear Regulatory Commission. Although seismic risks are an important contributor to the total nuclear risk, the occurence of earthquake-related seismic phenomena is low. Safety decisions involving seismic hazards must be made, however. This paper briefly described several categories of decisions that can be made using seismic risk analysis. While risk analysis does not provide all the information required for these decisions, it is a useful tool in that it provides additional information for the decision-making process. We anticipate a growing interest in the use of seismic risk analysis in nuclear safety evaluations.

29697 Probabilistic assessment of the primary coolant loop pipe fracture due to fatigue crack growth for a PWR plant. Chou, C.K. (California Univ., Livermore (USA). Lawrence Livermore National Lab.). *Nuclear Engineering and Design;* **71**: No. 3, 295-298(Aug 1982).

Presented at the 3. international seminar on the reliability of nuclear power plants.

The work reported herein assesses the probability of a double-ended quillotine break of the hot leg, cold leg and crossover line (for the purpose of this paper we defined it as a large LOCA) of a PWR plant subjected to the loads caused by plant transients and earthquakes. The work employs a fracture mechanics bases fatigue model to propagate cracks from an initial flaw distribution. Flaw size and aspect ratio, material properties, operating transient and seismic stress histories, pre-service and in-service inspections as well as leak detections are considered random variables to be input into the fatigue crack growth fracture mechanics model. A brief description of the model and interrelationship between various steps are also given.

29698 Effect of hydrogen on the oxygen embrittlement of beta-quenched Zircaloy-4 fuel cladding. Seiffert, S.L. (EG & G, Idaho Falls, Idaho, USA). *American Society for Testing and Materials, Special Technical Publication;* 303-328(1982). (CONF-800834—).

From 5. international conference on zirconium in the nuclear industry; Boston, MA, USA (4 Aug 1980).

Zircaloy cladding embrittlement was evaluated from data derived from the postirradiation examination of 47 light-water reactor type fuel rods irradiated under postulated accident conditions. The Zircaloy-4 cladding showed rapid oxygenation of the/beta/-phase Zircaloy and hydriding in excess of the pretest characterization. Fuel rods operated with a cladding defect were embrittled to a greater extent than intact rods oxidized under similar conditions. A modified background prior/beta/-phase and precipitation of rim-/alpha/was typically observed in the failure region of breached rods. The fracture resistance of breached rods appears to be related to enhanced hydrogen absorption and its influence on both the/alpha/-phase transformation and /alpha/-morphology during rapid (approximately 100 K/s) quenching. refs 5.

29699 Multi-dimensional arbitrary Lagrangian-Eulerian method for dynamic fluid-structure interaction. Wang, C.Y.; Zeuch, W.R. (Argonne Natl Lab, IL, USA). *American Society of Mechanical Engineers, Pressure Vessels and Piping Division, [Technical Report] PVP;* **64**: 298-316(1982). (CONF-820601—).

A description is given of an arbitrary Lagrangian-Eulerian method for analyzing fluid-structure interactions in fast reactor containment with complex internal structures. In the analysis, the fluid transient can be calculated either implicitly or explicitly, using a finite-difference mesh with vertices that may be moved with the fluid (Lagrangian), held fixed (Eulerian), or moved in any other prescribed manner (hybrid Lagrangian-Eulerian). The structural response is computed explicitly by two nonlinear, elastic-plastic finite element modules formulated in corotational coordinates. Interaction between fluid and structure is accounted for by enforcing the interface boundary conditions. The method has convincing advantages in treating complicated phenomena such as flow through perforated structures, large material distortions, flow around corners and irregularities, and highly contorted fluid boundaries. Several sample problems are given to illustrate the effectiveness of this arbitrary Lagrangian-Eulerian method. 12 refs.

29700 **Fluid transients and fluid-structure interaction.** Shin, Y.W.; Moody, F.J.; Au-Yang, M.K. . (Argonne Natl Lab, IL, USA). *American Society of Mechanical Engineers, Pressure Vessels and Piping Division, [Technical Report] PVP;* **64**: 381(1982). (CONF-820601—).

This conference proceedings contains 24 papers. The conference papers present new information and ideas in fluid-structural dynamics. The three major areas covered are: internal flows and transients, which includes fluid transients in various geometries; fluid and piping systems, which includes unsteady flow in both flexible and rigid piping systems; fluid/structure interaction, which includes new insights into the coupled response of fluid-structure systems. 13 articles are abstracted separately.

29701 **BLAZER: a RELAP5/MODI post processor to generate force-time history input data for structural computer codes.** Ware, A.G.; Williamson, R.L. (EG and G Idaho Inc, Idaho Fall, USA). *American Society of Mechanical Engineers, Pressure Vessels and Piping Division, [Technical Report] PVP;* **64**: 183-198(1982). (CONF-820601—).

A description is given of computer code BLAZER, a post processor to the RELAP5/MOD1 thermal hydraulics code. BLAZER computes fluid-induced piping forces and places them in structural code input format. The equations for properties and detailing the pressure, momentum, and acceleration components of the interaction force. A unique feature allows the number of time-force pairs describing the forcing functions to be reduced, since some structural codes such as NUPIPE-II limit this number. This reduction process maintains peaks and permits the concentration of force description points in time intervals where the forcing function experiences the most variation. The programs' plotting capability, which allows the analyst to compare the original and modified forcing functions and determine if proper reduction was achieved, is described. Input to structural codes SAP IV, NUPIPE-II, and ADINA can be produced by BLAZER. Capability to store intermediate results on tape is available. As an aid to the piping analyst, a step-by-step method for carrying out the calculation is included. 8 refs.

25 ENERGY STORAGE

REFER ALSO TO CITATION(S) 30106

29702 **(AECL—7410) Energy storage: a review of recent literature.** Tatone, O.S. (Atomic Energy of Canada Ltd., Chalk River, Ontario. Chalk River Nuclear Labs.). Dec 1981. 148p. NTIS (US Sales Only), PC A07/MF A01. Order Number DE83700410.

Recent literature on the technological and economic status of reversible energy storage has been reviewed. A broad range of research and development activities have been pursued between 1975 and the present. Most of this work has concentrated on improving technical and economic performance of previously known storage technologies. Hydraulic pumped storage with both reservoirs above ground and compressed air storage (1 plant) are the only methods that have been adopted by electric utilities. The need for electrical energy storage in Canada has not been acute because of the large proportion of hydraulic generation which incorporates some storge and, in most cases, can readily be used for load-following. Residential heat storage in ceramic room heaters has been used in Europe for several years. For Canadian climatic and market conditions larger, central heating units would be required. Residential heat storage depends upon utilities offering time-of-use rates and none in Canada do so at present. Most seasonal storage concepts depend upon storage of low-grade heat for district heating. The cost of energy storage is highly dependent upon annual energy throughput and hence favours smaller capacity systems operating on frequent charge/discharge cycles over long-term storage. Capital costs of energy storage methods from the literature, expressed in constant dollars, are compared graphically and tentative investment costs are presented for several storage methods.

2502 Compressed Gas

29703 **(PNL—4687) Subsurface monitoring of reservoir pressure, temperature, relative humidity, and water content at the CAES Field Experiment, Pittsfield, Illinois: system design.** Hostetler, D.D.; Childs, S.W.; Phillips, S.J. (Energy Resource Management, Tucson, AZ (USA)). Mar 1983. Contract AC06-76RL01830. 107p. NTIS, PC A06/MF A01. Order Number DE83010934.

This subsurface-instrumentation design has been developed for the first Compressed Air Energy Storage (CAES) field experiment to be performed in porous media. Energy storage will be accomplished by alternating the injection and withdrawal of compressed air in a confined sandstone aquifer near Pittsfield, Illinois. The overall experiment objective is to characterize the reservoir's geochemical and thermohydraulic response to imposed CAES conditions. Specific experiment objectives require monitoring: air-bubble development; thermal development; cyclic pressure response; reservoir dehydration; and water coning. Supporting these objectives, four parameters will be continuously monitored at depth in the reservoir. They are: temperature; pressure; pore-air relative humidity; and pore-water content. Reservoir temperatures and pressures will range to maximum values approaching 200°C and 300 psi, respectively. Both pore-air relative humidity and pore-water content will range from ~ 0 to 100%. This report discusses: instrumentation design; sensor and sensor system calibration; field installation and testing; and instrument-system operation. No comprehensive off-the-shelf instrument package exists to adequately monitor CAES reservoir parameters at depth. The best available sensors were selected and adapted for use under expected ranges of reservoir conditions. The instrumentation design criteria required: suitable sensor accuracy; continuous monitoring capability; redundancy; maximum sensor integrity; contingency planning; and minimum cost-information ratio. Three wells will be instrumented: the injection/withdrawal (I/W) well and the two instrument wells. Sensors will be deployed by wireline suspension in both open and backfilled (with sand) wellbores. The sensors deployed in the I/W well will be retrievable; the instrument-well sensors will not.

2503 Pumped Hydro

29704 **(EPRI-EM—2891) Analytic predictions of circulation and vortices at intakes. Final report.** Brocard, D.N.; Beauchamp, C.H.; Hecker, G.E. (Worcester Polytechnic Inst., Holden, MA (USA). Alden Research Lab.). Mar 1983. 81p. NTIS, PC A05/MF A01. Order Number DE83901932.

Prediction of free surface vortices usually requires an overall physical hydraulic model to correctly simulate the intake approach flow. This approach is generally reliable, but it lacks flexibility and may be costly. This report describes a proposed alternate prediction technique in which a two-dimensional finite elements model is used to calculate the intake approach flow circulation from which vortex activity can be predicted through intake nearfield experimental data. Hydraulic experiments were undertaken with several reservoir configurations and withdrawal flowrates. Circulations at different distances from the intake were measured using specially designed quadripod devices, vortex activity recorded, and determinations made of the exact conditions leading to an air drawing vortex. The generation of circulation by Coriolis forces and the transport of circulation towards the intake were investigated theoretically and the ability of a finite elements model to simulate these phenomena was evaluated. The finite elements simulation of the generation of circulation in the farfield was investigated by comparison with the hydraulic experiments. Using higher values of the eddy viscosity in the farfield than near the intake, reasonable simulation of the intake approach flow circulation could be obtained. The proposed vortex prediction technique has been shown to be well founded but further work needs to be done before the method can be applied for a proposed pumped storage reservoir.

2506 Thermal

REFER ALSO TO CITATION(S) 29463

29705 (ANL/SPG—23) Evaluation and assessment of thermal-energy storage for residential heating. Hersh, H.; Mirchandani, G.; Rowe, R. (Argonne National Lab., IL (USA)). Apr 1982. Contract W-31-109-ENG-38. 175p. NTIS, PC A08/MF A01. Order Number DE83010694.

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In a field test in Maine and Vermont involving 75 households, 45 of which used off-peak electricity for heating, the overall technical performance and user acceptance of thermal-energy storage (TES) heaters were found to be satisfactory. Annual energy consumption for households using TES heaters was the same as for control households using conventional electric baseboard heaters. Proper sizing is more critical for TES systems than for conventional heaters. Barriers to rapid market penetration include high capital cost, uncertainties about the long-term availability of incentive rates, and competition from bivalent heating systems and nonstorage heating units that take better advantage of time-of-day rates. Actual building heat losses were 30% to 50% less than estimated by walk-through audits.

29706 (CONF-820312—1) Review of latent heat storage technology. Michaels, A.I. (Argonne National Lab., IL (USA)). 1982. Contract W-31-109-ENG-38. 24p. NTIS, PC A02/MF A01. Order Number DE83009681.

From Solar storage workshop; Jeddah, Saudi Arabia (21 Mar 1982).

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The technological status of energy storage in the latent heat of phase transformations is reviewed. Emphasis is on utilization of the heat of fusion in freezing and melting, but several solid-solid phase transformations are included. Recently marketed latent-heat-storage (LHS) devices, and others in the prototype development and testing stage are described. A discussion is presented on coolness storage in the water/ice phase transformation, particularly of systems which utilize environmental freezing and seasonal ice storage. Finally, a survey of R and D activities is presented, including: heat-transfer phenomena; advanced phase-change materials; advanced packaging and heat-exchange methods; and LHS in passive-solar applications. From this review, it appears that, in general, LHS remains more expensive than competing sensible heat storage, but in some systems cost equality or savings are indicated. The additional benefits of reduced volume and a narrow storage and retrieval temperature range make LHS the preferred option in many applications.

2509 Batteries

REFER ALSO TO CITATION(S) 29515, 29523, 29524, 29796, 29861

29707 (AD-A—122907/9) Charge efficiency and charge utilization in the sealed nickel-cadmium cell. Technical report. Zimmerman, A.H.; Effa, P.K. (Aerospace Corp., El Segundo, CA (USA). Chemistry and Physics Lab.). 20 Dec 1982. 23p. NTIS, PC A02/MF A01.

The charge efficiency of the nickel-cadmium cell is found to be 100% up to the state of charge where oxygen evolution begins to take place. Inefficiencies at lower states of charge are due to poor utilization of capacity on discharge rather than to any inefficiency in rechargability. The dependence of the utilization efficiency on charge and discharge rates is reported. The results are consistent with the hypothesis that the utilization of capacity in the nickel electrode is limited by the formation of a depletion layer at the current collector-active material interface.

29708 (ANL/OEPM—83-1) Lead-acid battery pulse-discharge investigation. Phase II. Final report. Dowgiallo, E.; Caulder, S.; Simon, A. (Army Mobility Equipment Research and Development Command, Fort Belvoir, VA (USA). Electrical Power Lab.; Naval Research Lab., Washington, DC (USA)). Aug 1982. Contract W-31-109-ENG-38. 37p. NTIS, PC A03/MF A01. Order Number DE83011027.

In the first phase of the study, the effects of high current pulses caused by electric vehicle controllers on the energy, life, and microstructure of ESB EV-106 batteries were investigated. The above studies showed that there were detrimental effects associated with pulse discharges on the positive plate, and that, while the results require further quantitative analysis, preliminary indications are that the capacity of the batteries exhibited no significant anomalies associated with the pulsed nature of the discharge. The purpose of this study was to obtain preliminary information regarding the following: (a) the relationship between the internal morphological changes of the battery and the numbers of pulsed discharge cycles, and (b) how different sequences of pulsed and steady state discharges affect the internal morphology of the battery. Test procedures and results are detailed. (WHK)

29709 (CONF-810812—59) Calcium/iron disulfide secondary cells. Preto, S.K.; Ross, L.E.; Otto, N.C.; Lomax, J.F.; Roche, M.F. (Argonne National Lab., IL (USA)). 1981. Contract W-31-109-ENG-38. 4p. NTIS, PC A02/MF A01. Order Number DE83010810.

From 16. intersociety energy conversion engineering conference (IECEC); Atlanta, GA, USA (9 Aug 1981).

A Ca-Al/Si/FeS_2 cell which employs a molten LiCl-NaCl-$CaCl_2$-$BaCl_2$ (mp 383°C) electrolyte has been developed. A specific energy of 70 Wh/kg at the 5-h rate and a cycle life of 200 cycles have been achieved in bicell designs. At present, the cell life is limited by declining coulombic efficiency, and the cell power is limited by a gradual increase in cell resistance. These problems will be addressed in future studies of the system. Ultimately, multiplate cells based on this system are expected to have a specific energy of 160 Wh/kg and a cycle life of 1000 cycles.

29710 (CONF-820508—10) Lead deficiency and hydrogen content in battery electrode β-PbO_2. Jorgensen, J.D.; Varma, R.; Rotella, F.J.; Cook, G.; Yao, N.P. (Argonne National Lab., IL (USA)). 1982. Contract W-31-109-ENG-38. 18p. NTIS, PC A02/MF A01. Order Number DE83010812.

From Spring meeting of the Electrochemical Society; Montreal, Canada (9 May 1982).

Neutron powder-diffraction data have been collected for β-PbO_2 obtained from lead-acid battery plates cycled in H_2SO_4 and D_2SO_4. A comparison of total scattering cross sections for the hydrogenated sample versus the deuterated sample indicates a bulk hydrogen concentration of 0.21 H atoms per PbO_2 unit. Rietveld refinements of the data yield the expected tetragonal β-PbO_2 structure, $P4_2/mnm$, with a 3 to 5% vacancy concentration on the lead sites. These results suggest that at least part of the hydrogen is incorporated into the β-PbO_2 crystalline lattice.

29711 (CONF-820621—6) Engineering characteristics of secondary lithium/iron sulfide batteries. Chilenskas, A.A.; Gay, E.C.; Steunenberg, R.K.; Barney, D.L. (Argonne National Lab., IL (USA)). 1982. Contract W-31-109-ENG-38. 13p. NTIS, PC A02/MF A01. Order Number DE83010646.

From 30. power sources symposium; Atlantic City, NJ, USA (7 Jun 1982).

Performance characteristics of some lithium/iron sulfide batteries are discussed. Energy and power potential, charge/discharge characteristics, reliability, and efficiency are considered. (WHK)

29712 (CONF-821015—11) Statistical analysis of lithium/iron sulfide status cell cycle life and failure mode. Gay, E.C.; Battles, J.E.; Miller, W.E. (Argonne National Lab., IL (USA)). 1982. Contract W-31-109-ENG-38. 3p. NTIS, PC A02/MF A01. Order Number DE83010734.

From Electrochemical Society fall meeting; Detroit, MI, USA (17 Oct 1982).

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For the past several years, Li-Al/FeS cells for electric vehicles have been developed at Argonne National Laboratory (ANL) and its industrial subcontractors (Eagle-Picher Industries, Inc. and Gould Inc.). The performance goals of these cells are (1) high reliability, (2) a specific energy of 125 Wh/kg at the 3-h rate, and (3) peak specific power of 185 W/kg at 50% charge. Progress in the fabrication and development of cells toward achieving these goals was determined by life-tests at ANL for groups of 12 or more iden-

tical state-of-the-art cells (status cells) supplied by each contractor. These cells were operated to obtain data for statistical analysis of cell cycle life, performance and failure modes. The major task confronted in the cycle life study was to assess the applicability of a selected statistical model on the basis of the given data. This was accomplished using two approaches: probability plotting, and analysis of the data using the W-test and the Kolmogorov-Smirnov statistical test for goodness of fit. Based on these tests, the Weibull distribution provided an adequate representation of the data. The end of life for the status cells was defined as a 20% loss of the initial stabilized capacity or a decrease to less than 95% coulombic efficiency.

29713 **(CONF-821211—7) Sodium/alkali nitrate cell studies.** Roche, M.F. (Argonne National Lab., IL (USA)). 1982. Contract W-31-109-ENG-38. 2p. NTIS, PC A02/MF A01. Order Number DE83010567.

From 5. DOE battery and electrochemical contractors' conference; Crystal City, VA, USA (7 Dec 1982).

Sodium/β''/alkali-nitrate secondary cells are being studied in this research program. The goal of these studies is a sodium cell that will operate at a temperature of about 200°C, wich is 150°C lower than the operating temperature of sodium/β''/sulfur cells. The expected benefits of a lower operating temperature are improved cell life through lower corrosion rates and improved energy efficiency through lower heat losses. Progress is briefly reviewed.

29714 **(CONF-821211—8) Post-test analysis of Gould and Eagle-Picher cells.** Battles, J.E. (Argonne National Lab., IL (USA)). 1982. Contract W-31-109-ENG-38. 8p. NTIS, PC A02/MF A01. Order Number DE83010568.

From 5. DOE battery and electrochemical contractors' conference; Crystal City, VA, USA (7 Dec 1982).

Post-test examinations, which have been an important part of the Li-Al/FeS battery development program, have provided valuable information for recommendations on designs to achieve improved cell performance and reliability and for the selection of materials. The major objective of the post-test examinations has been the determination of cell-failure mechanisms. Other objectives are the determination of the electrode microstructure, the distribution, uniformity and utilization of active materials, and the in-cell corrosion of current-collector materials. These post-test examinations include metallography, chemical analysis, x-ray diffraction, ion- and electron-microprobe analysis, and scanning electron microscopy. Because the cell materials (LiCl KCl, LiAl, Li_2S) react rapidly with the ambient atmosphere, a unique helium-atmosphere facility was constructed for the post-test examination of cells. The results to be presented in this paper pertain to the failure analysis of Eagle-Picher and Gould status cells, the microstructure of the Li-Al electrode, and the in-cell corrosion of current-collector materials.

29715 **(CONF-821211—9) Electrochemical studies of metal-disulfide electrodes.** Tomczuk, Z. (Argonne National Lab., IL (USA)). 1982. Contract W-31-109-ENG-38. 7p. NTIS, PC A02/MF A01. Order Number DE83010641.

From 5. DOE battery and electrochemical contractors' conference; Crystal City, VA, USA (7 Dec 1982).

A basic research effort on the electrochemistry and related physical properties of metal-disulfide electrodes, with special emphasis on the FeS_2 electrode, is being carried out at Argonne National Laboratory. The objective of this work is the generation of basic information which can be used in the development of positive electrodes for advanced battery systems. The work has been directed toward the identification of sulfur-containing species formed during the charge and discharge of the metal disulfide electrodes (metal = Fe, Co, or Ni); the solubility of these species in LiCl-KCl electrolyte as a function of temperature, and the acquisition of thermodynamic data for the various phase transitions that occur in the FeS_2 electrode. The techniques used in this research effort included cyclic voltammetry, absorption spectroscopy, and equilibrium emf measurements.

29716 **(CONF-821211—10) Argonne National Laboratory Li-alloy/FeS cell testing and R & D programs.** Gay, E.C. (Argonne National Lab., IL (USA)). 1982. Contract W-31-109-ENG-38. 7p. NTIS, PC A02/MF A01. Order Number DE83010642.

From 5. DOE battery and electrochemical contractors' conference; Crystal City, VA, USA (7 Dec 1982).

Groups of 12 or more identical Li-alloy/FeS cells fabricated by Eagle-Picher Industries, Inc. and Gould Inc. were operated at Argonne National Laboratory (ANL) in the status cell test program to obtain data for statistical analysis of cell cycle life and failure modes. The cells were full-size electric vehicle battery cells (150 to 350 Ah capacity) and they were cycled at the 4-h discharge rate and 8-h charge rate. The end of life was defined as a 20% loss of capacity or a decrease in the coulombic efficiency to less than 95%. Seventy-four cells (six groups of identical cells) were cycle-life tested and the results were analyzed statistically. The ultimate goal of this analysis was to predict cell and battery reliability. Testing of groups of identical cells also provided a means of identifying common failure modes which were eliminated by cell design changes. Mean time to failure (MTTF) for the cells based on the Weibull distribution is presented.

29717 **(CONF-830508—9) Solubility of Li_2S in LiF-LiCl-LiBr electrolyte: measurements and calculations.** Tomczuk, Z.; Vissers, D.R.; Saboungi, M.L. (Argonne National Lab., IL (USA)). 1983. Contract W-31-109-ENG-38. 3p. NTIS, PC A02/MF A01. Order Number DE83009592.

From Electrochemical Society meeting; San Francisco, CA, USA (8 May 1983).

High performance lithium-alloy/iron sulfide cells are currently being developed at Argonne National Laboratory and at several industrial firms for electric vehicle propulsion. These cells operate at high temperatures and utilize Li-Al or Li-Si negative electrodes, FeS positive electrodes, and a molten salt electrolyte. In the early work, the molten salt was the LiCl-KCl eutectic (58.2 mol % LiCl-41.8 mol % KCl), but in recent work various electrolyte compositions have been used, i.e., LiCl-rich LiCl--KCl (typically 67 mole % LiCl), LiF-LiCl-KCl, or LiF-LiCl-LiBr (1). The use of these electrolytes requires cell operating temperatures in the range of 703-773 K. As these cells are cycled, it has been shown that, when LiCl-KCl electrolytes were used, local electrolyte compositional changes occurred because of ion transport processes and chemical reactions in the cells. However, despite the temperature or the nature of the electrolyte, iron and lithium sulfide are the final discharge products. Thus, a systematic investigation of the solubility of Li_2S in a variety of electrolytes containing LiCl as a function of temperature is of technological importance in the development of these cells. We report new solubility measurements of Li_2S in the LiF-LiCl--LiBr eutectic solution (22 mol %-31 mol %-47 mol %) at 739 and 773 K. The observed increase of Li_2S solubility as the solvent is changed from LiCl-KCl to LiF-LiCl-LiBr and then to LiF-LiCl is explained in terms of known molten salt theories.

29718 (SERI/CP—234-1577, pp 47-57) **Review of the Rockwell thermally regenerative alloy cell (TRAC) system.** Yosim, S.J. (Rockwell International Corp., Canoga Park, CA). 1981. NTIS, PC A11/MF A01.

From Thermo regenerative electrochemical systems workshop; Alexandria, VA, USA (3 Dec 1981).

The system is a closed-cycle, static device for converting heat into electricity. It operates by electrochemically reacting streams of sodium amalgam and mercury in galvanic cells, producing electrical power, and then theremally separating the combined material into fresh reactants by distillation. As in many other thermally regenerative systems developed during that period, emphasis was placed on space applications using nuclear fuel as a source of thermal power. Thus, much of the research on the TRAC system was aimed at high ratios of power output to weight - rather than at the highest possible efficiency of the system. The TRAC test program concentrated on cell development, with emphasis on the long-term stability of the materials and components. Static electrode cells and flowing electrode cells with a tubular electrode matrix were designed, built, and tested. Tests of a combined cell and regeneration loop were carried out, one involving operation of the cell for a total of 1197 h. These tests demonstrated the technical feasibility of the TRAC system concept and demonstrated the potential for a long-life system. An analytical study was done to estimate the efficiency and specific power of a 3-kWe, Po-210 radioisotope-powered system. Operating temperatures for the cell of ap-

proximately 460 to 510°C and for the regenerator of 670 to 700°C were imposed, thus allowing a maximum Carnot efficiency of the order of 20%. The actual efficiency was reduced to about one-half of that value because of irreversibilities and was reduced further by weight constraints to about 30% of the Carnot efficiency.

29719 **(SAND—83-6002) Manufacturing process for a high-temperature electrochemical element.** Chobanov, T.; Kunze, D.; Woeffler, F. (Sandia National Labs., Albuquerque, NM (USA)). Mar 1983. Contract AC04-76DP00789. C; French Patent Application No. 81-16496. 14p. NTIS, PC A02/MF A01. Order Number DE83010255.

The present invention is related to a process for the manufacture of a high-temperature electrochemical element including a solid positive electrode, a solid negative electrode, a separator made of a finely dispersed ceramic type material set in the component parts of the element.

29720 **A method of determining battery life.** Papazian, H.A. US Patent Application 6-431,496. 30 Sep 1982. 14p.

A method of determining battery life is shown wherein a dielectric constant sensor measures the dielectric constant value of the electrolyte of the battery. The measured dielectric constant value is compared to empirical values to provide battery status. In particular, a fluid electrolyte initially composed of thionyl chloride changes during discharge or aging to an electrolyte having sulfur monochloride therein. Based upon the changes in dielectric constant between the initial fully charged state to the fully discharged state, the battery status is obtained.

29721 **Electrochemical cell having an alkali-metal-nitrate electrode.** Roche, M.F.; Preto, S.K. US Patent Application 6-385,202. 4 Jun 1982. 12p. Contract W-31-109-ENG-38.

A power-producing secondary electrochemical cell includes a molten alkali metal as the negative-electrode material and a molten-nitrate salt as the positive-electrode material. The molten material in the respective electrodes are separated by a solid barrier of alkali-metal-ion conducting material. A typical cell includes active materials of molten sodium separated from molten sodium nitrate and other nitrates in mixture by a layer of sodium β'' alumina.

29722 **Feedthrough terminal for high-power cell.** Kaun, T.D. US Patent Application 6-382,998. 28 May 1982. 18p. Contract W-31-109-ENG-38.

A feedthrough terminal for a high power electrochemical storage cell providing low resistance coupling to the conductive elements therein while isolating the terminal electrode from the highly corrosive environment within the cell is disclosed. A large diameter, cylindrical copper electrode is enclosed in a stainless steel tube with a BN powder feedthrough seal maintained around the stainless steel tube by means of facing insulative bushings and an outer sleeve. One end of the copper conductor is silver-brazed directly to a flat, butterfly bus bar within the cell, with the adjacent end of the surrounding outer feedthrough sleeve welded to the bus bar. A threaded seal is fixedly positioned on a distal portion of the stainless steel tube immediately adjacent the distal insulative bushing so as to compress the feedthrough seal in tight fitting relation around the stainless steel tube in providing a rugged, leak-proof electrical feedthrough terminal for the power cell.

29723 **Process for the synthesis of iron powder.** US Patent Application 6-375,519. 6 Mar 1982. 39p. Contract AC04-76DP00656.

Portions are illegible in microfiche products.

A process for preparing iron powder suitable for use in preparing the iron-potassium perchlorate heat-powder fuel mixture used in thermal batteries, comprises preparing a homogeneous, dense iron oxide hydroxide precipitate by homogeneous precipitation from an aqueous mixture of a ferric salt, formic or sulfuric acid, ammonium hydroxide and urea as precipitating agent; and then reducing the dense iron oxide hydroxide by treatment with hydrogen to prepare the iron powder.

29724 **Secondary batteries - new batteries: high temperature.** Cairns, E.J. (Lawrence Berkeley Lab., CA). pp 341-370 of Comprehensive treatise of electrochemistry. Vol. 3. Bockris, J.O.M.; Conway, B.E.; Yeager, E.; White, R.E. (eds.). New York, NY; Plenum Publishing Corp. (1981).

The state of the art in high temperature secondary batteries is reviewed. Two groups are discussed: sodium cells with solid electrolytes and lithium and calcium cells with molten-salt electrolytes. A summary of current performance, recent work and outstanding problems is given for each system considered. (KAW)

29725 **Application of sweep voltammetry techniques to high-temperature solid electrolyte systems.** Yang, C.Y.; Isaacs, H.S. (Brookhaven National Lab., Upton, NY). *Journal of Electroanalytical Chemistry;* **123**: 411-417(1981). Contract AC02-76CH00016.

Sweep voltammetry techniques are commonly applied to liquid electrolyte electrochemical systems to study redox reactions. Important parameters related to the reactions such as rate constant, Tafel slope and diffusivity of the redox species, etc., can be easily obtained. However, these techniques have only been infrequently applied to solid electrolyte systems. In the work described here, sweep voltammetry techniques applied to electrode studies in high-temperature oxide electrolyte systems will be discussed. Mixed metal-metal oxides are commonly used as reference electrodes in high-temperature oxide electrolyte systems such as oxygen sensors, oxygen pumps, etc. Therefore, it is of great interest to study the performance and oxygen transport mechanisms of these materials. The results presented here provide some information on the transport processes of oxygen across the electrode/electrolyte interface as well as the interaction between oxygen across the electrode/electrolyte interface as well as the interaction between oxygen and metals at high temperature. It will also be shown that sweep voltammetry techniques can be used in the studies of the initial stages of high temperature metal oxidation.

29 ENERGY PLANNING AND POLICY

REFER ALSO TO CITATION(S) 29053, 29260, 29261, 29769

29726 **(DOE/EIA—0204(83/01)) EIA Publications: New Releases No. 61, January-February 1983.** (Department of Energy, Washington, DC (USA). Energy Information Administration). 29 Mar 1983. 25p. NTIS, PC A02/MF A01. Order Number DE83009948.

EIA Publications: New Releases is a biomonthly report on the newest available Energy Information Administration (EIA) publications and upcoming reports. It includes news about EIA, as well as many other items of special interest. Anyone interested in the most current material and activity on energy data sould find the report useful.

29727 **(DOE/IG—0147) Reexamination of the oil-transfer pricing program.** (Department of Energy, Washington, DC (USA). Office of Inspector General). 18 Mar 1981. 19p. K. Order Number DE83007996.

Report to The Secretary, Acting Deputy Secretary.

In 1978, the IG examined the oil transfer pricing program noted undue delay by program management in identifying excessively high transfer prices and in proposing cost disallowances. This followup audit showed some improvement but these additional recommendations were offered to further strengthen DOE management: issue notices of proposed disallowances more expeditiously; ensure that potential settlements adequately reflect the extent of actual violations identified in 1977-1978; and complete as soon as possible the review of transfer prices for the period beginning in 1979 and then continue the review on a current basis. Comments from the Administrator, Economic Regulatory Administration are appended. (PSB)

29728 **(DOE/IG—0148) Continuing management problems in the weatherization program in the State of Washington.** (Department of Energy, Washington, DC (USA). Office of Inspector General). 9 Mar 1981. 38p. K. Order Number DE83007998.

Report to The Secretary, Deputy Secretary.

This report shows a general failure at the five community agencies reviewed to properly account for and control weatherization program funds and assets. Improper and duplicate billings were received and paid by the state. Charges were made against grant funds without accounting support. Inventories of materials and equipment were not properly maintained or safeguarded. Although this program is designed to assist low-income persons, eligibility was not routinely verified and abuse occurred. Recommendations include spot visits and financial audits; insuring compliance with federal audit requirements; and to suspend funding to grant recipients that do not correct accounting and control deficiencies. Responses from program officials detailing corrective actions are appended. (PSB)

29729 **(DOE/IG—0149) Thefts of property: James Forrestal Building.** (Department of Energy, Washington, DC (USA). Office of Inspector General). 23 Mar 1981. 12p. K. Order Number DE83007999.

Report to The Secretary.

As a result of a review, the IG concluded that the Department of Energy should insist on improved theft reporting and make a greater effort to monitor the security program at the Forrestal Building. Therefore, we are recommending that the Assistant Secretary for Defense Programs, which includes the Office of Safeguards and Security, reevaluate the security requirements for the James Forrestal Building in cooperation with GSA and institute an improved program to reduce thefts.

29730 **(DOE/IG—0165) Investigation of allegations made in a fourteen-page document.** (Department of Energy, Washington, DC (USA). Office of Inspector General). 2 Jul 1981. 37p. K. Order Number DE83007277.

Report to The Secretary.

The fourteen-page document anonymously submitted to the Office of Government Ethics makes five allegations concerning Mr. Leslie Daly. These allegations fall into three categories: (1) three allegations concerning Mr. Daly's relationship with Northrop Corporation, his former employer; (2) an allegation concerning Mr. Daly's travel to California while a DOE employee; and (3) a final allegation concerning the hiring of Mr. Daly's daughter by the International Energy Agency in Paris. Investigative efforts addressed all allegations but found no substantive violations. (PSB)

29731 **(DOE/IG—0170) Questionable payments for work of a contractor.** (USDOE Office of Inspector General, Washington, DC). 23 Sep 1981. 54p. USDOE-TIC, PO Bx 62, Oak Ridge, TN 37830.

Report to The Secretary.

Examination of three support contracts for international R and D disclosed fundamental weaknesses in DOE controls over the (1) receipt and acceptance of goods and services, (2) authorization and payments for work, and (3) analyses of price proposals submitted by the contractor. As a result of these weaknesses, there was no clear and convincing record of what DOE got for most of the $2.5 million it spent on these contracts. Neither was there a downward adjustment in the amounts paid by DOE under two of the contracts although such an adjustment was required by the contracts. Much of the work done by the contractor was not properly authorized. Finally, analyses by the San Francisco Operations Office of certain of the price proposals submitted by the contractor did not ensure that DOE obtained a fair and reasonable price. Recommendations addressed these issues to the Procurement Office, the Controller, the Assistant Secretaries for Conservation and Renewable Energy and Fossil Energy, and the Manager, San Francisco Operations Office who indicated general agreement with the findings and a willingness to immediately pursue the remedial measure that were recommended. Their comments are appended.

29732 **(DOE/PR/10108—2) Directory of women-owned businesses in energy-related and other fields.** (National Association of Women Federal Contractors, Washington, DC (USA)). Dec 1982. Contract FG01-80PR10108. 264p. NTIS, PC A12/MF A01. Order Number DE83008129.

This directory is divided into three sections for easy cross-referencing: Section I contains a complete alphabetized list of women-owned businesses (WOB's) with detailed profiles on each company, it includes company name, address, phone number, contact person, geographical region, primary service area, years in business, description of services/goods and number of permanent personnel; Section II contains a commodity/service key word listing; Section III contains a listing of WOBs within each of the ten federal geographical regions, which are grouped by standard industrial classification (SIC) codes. The directory contains 423 companies which were obtained by soliciting information on over 3000 WOBs. The capabilities of the companies listed cover the spectrum of commodities and services purchased by the Department of Energy and its government owned/contractor operated facilities. Companies engaged in manufacturing, construction, research and development and professional services are inlcuded in this directory.

2901 Energy Analysis And Modeling

29733 **(CONF-770549—2) Progress report on the PILOT energy modeling project. Technical report SOL 77-11.** Parikh, S.C. (Stanford Univ., CA (USA). Systems Optimization Lab.). May 1977. Contract AT03-76EI70052. 40p. NTIS, PC A03/MF A01. Order Number DE83009927.

From Workshop on energy strategies; Laxenburg, Austria (18 May 1977).

The mid-1976 version of the PILOT model is described together with four illustrative scenarios. Its main deficiencies and key model developments in progress are briefly reviewed. Finally, a sketch of a welfare equilibrium variant of PILOT is given.

29734 **(DOE/EI/10601—T1) Survey of research on model aggregation and simplification. Technical report SOL 79-26.** Lansdowne, Z.F. (Stanford Univ., CA (USA). Systems Optimization Lab.). Oct 1979. Contract AT03-79EI10601;AT03-76EI70052. 89p. NTIS, PC A05/MF A01. Order Number DE83009914.

This report gives a survey of aggregation and simplification results that are relevant for energy-economic modeling. The aggregation section reviews results for demand functions, production functions, input-output models, expanding economies, linear programs, networks, and infinite planning horizons. The simplification section reviews results for linearization, penalty functions, pseudo data, and input-output models.

29735 **(DOE/EI/10601—T2) Modified aggregation program for the PILOT process integrated model. Technical report SOL 80-31.** Hirose, H. (Stanford Univ., CA (USA). Systems Optimization Lab.). Dec 1980. Contract AT03-79EI10601;AT03-80EI10682. 50p. NTIS, PC A03/MF A01. Order Number DE83010109.

The PILOT Process Integrated Model can produce energy/economic scenarios for time periods of up to 100 years by aggregating several 5 year time periods into one. This report presents modification to an existing aggregation method that utilizes the special structure of the Consumers Energy Service Model (CESM) and the Industrial Energy Service Model (IESM) and reduces aggregation bias in these portions of the PPIM.

29736 **(DOE/EI/10601—T3) Network formulation of the Midterm Energy Market Model (MEMM). Technical report SOL 80-5.** Lansdowne, Z.F. (Stanford Univ., CA (USA). Systems Optimization Lab.). May 1980. Contract AT03-79EI10601. 107p. NTIS, PC A06/MF A01. Order Number DE83010108.

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The Midterm Energy Market Model (MEMM) is an equilibrium model that forecasts the quantities and prices at which supplies equal demands for many different fuels. In earlier documenta-

tion, MEMM is referred to as the PIES (Project Independence Evaluation System) integrating model. Because the current version of MEMM has a long running time, the purpose of this study is to simplify its calculations in order to reduce the time needed for solution. The approach used for accomplishing this reduction is to take advantage of the network structure present in MEMM. This structure includes: an acyclic directed graph; two kinds of nodes; and multicommodity flows. The two kinds of nodes are: decision nodes, which allow the flow on each outgoing arc to be freely chosen subject to conservation of flow and non-negativity constraints; and non decision nodes, which require the flow on each outgoing arc to be a specified percentage of the total incoming flow, but conservation of flow needs not hold. This report describes a solution algorithm which takes advantage of this network structure, and gives illustrative network diagrams for several energy supply activities.

29737 **(DOE/EI/70052—T2) National energy potential according to PILOT.** Barzelay, M. (Stanford Univ., CA (USA). Systems Optimization Lab.). Jun 1977. 89p. NTIS, PC A05/MF A01. Order Number DE83009928.

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PILOT, a decision-making tool for the energy policy-making process, closely examines the energy/economy interrelation. This interim report is designed to give the decision maker a frame of reference for making energy policy decisions. Three energy availability scenarios are presented. A middle ground scenario, referred to as the base case, is juxtaposed with high and low energy availability scenarios. These cases are by no means exclusive: the decision maker needs only to provide the restrictions to be placed on the use of energy resources and the computer determines the output data. Decision makers interested in additional scenario runs of PILOT should correspond with the Stanford Department of Operations Research. Part I defines the energy problem and presents in greater detail the fundamental assumptions. Part II describes the results of three scenarios on the availability of energy resources. A comparison of scenarios is presented in Part III.

29738 **(DOE/EI/70052—T8) Detailed sectoral modeling in a dynamic, multisector, welfare-equilibrium framework. Technical report SOL 77-28.** Parikh, S.C. (Stanford Univ., CA (USA). Systems Optimization Lab.). Oct 1977. 23p. NTIS, PC A02/MF A01. Order Number DE83009894.

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An approach is presented through an application to the energy sector for modeling a given sector of an economy in detail within a dynamic, multisector, welfare equilibrium framework. It amalgamates the economic modeling approaches of optimal economic growth, input-output analysis, intertemporal competitive market equilibrium, and optimal extraction rate of an exhaustible resource. Implementation in the PILOT System is in terms of a linear programming model with approximately 900 rows and 3000 columns. Possible applications are briefly discussed and an illustration is given.

29739 **(DOE/EI/70052—T9) Plutonium issue: an analysis of policies deferring the introduction of plutonium-fueled reactors in the US. Technical report SOL 78-24.** Avi-Itzhak, B.; Connolly, T.J. (Stanford Univ., CA (USA). Systems Optimization Lab.). Sep 1978. Contract AT03-76EI70052. 112p. NTIS, PC A06/MF A01. Order Number DE83009916.

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One feature of the energy policy of the present US Administration is to defer indefinitely both the reprocessing of spent nuclear fuel and the commercialization of the breeder reactor. This study makes use of Stanford's PILOT energy-economic model in estimating the economic benefits foregone as a function of the deferral duration. Based on these estimates, upper and lower bounds for the optimal duration of the deferral are established. The methodology and major findings of the study are outlined in Section 1, followed by a brief description of the PILOT model and a presentation of the projected energy results for the various scenarios. Special attention is given to the results of the nuclear sector which are presented in greater detail and complemented by discussion. The economic benefits of plutonium, as measured by PILOT, are presented and discussed in Section 4 followed by the analysis of the deferral strategies.

29740 **(DOE/EI/70052—T10) Welfare equilibrium model (WEM) of energy supply, energy demand, and economic growth. Technical report SOL 79-3.** Parikh, S.C. (Stanford Univ., CA (USA). Systems Optimization Lab.). Mar 1979. Contract AT03-76EI70052. 227p. NTIS, PC A11/MF A01. Order Number DE83009923.

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A computer model called Welfare Equilibrium Model is documented as an intermediate scale linear programming model for developing internally consistent long-run projections of energy supply, energy demand, and economic growth within an economic framework of aggregate consumer welfare maximization and competitive market equilibrium. It is a tool for integrated long term planning of the US energy system, and for comparing options designed to provide a transition from the economy that is heavily dependent on oil and gas to an economy that is dependent on a balanced fuel mix and cost effective energy conservation. WEM contains approximately 700 constraints and 3000 variables. Approximations of many nonlinear functions are included in it. It requires about 10 to 12 minutes on an IBM 370/168 machine to find an economic equilibrium from cold start using the MPS3 mathematical programming software. Parametric studies take from 0.5 to 5 minutes per case, with approximately 1.5 minutes as the median.

29741 **(DOE/EI/70052—T11) Model of interfuel and capital-fuel substitution by consumers. Technical report SOL 78-22.** Weyant, J.P.; Buras, N.; Swift, M. (Stanford Univ., CA (USA). Systems Optimization Lab.). Nov 1978. Contract AT03-76EI70052. 137p. NTIS, PC A07/MF A01. Order Number DE83009922.

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A multi-period process model of consumer demand for energy is developed. Four end-uses are explicitly considered: space heat, other thermal (water heat, cooking and clothes drying), air conditioning, and automobile transport. Comparison of results with those from the PILOT physical flow model illustrate the impact of changes in relative prices on consumer demands. Thus, formal linkage with the PILOT system is proposed. Finally a number of extensions that could improve the realism of the model are described.

29742 **(DOE/EI/70052—T12) Consumers energy-services model. Technical report SOL 79-16.** Avi-Itzhak, B.; Iusem, A. (Stanford Univ., CA (USA). Systems Optimization Lab.). Sep 1979. Contract AT03-76EI70052. 118p. NTIS, PC A06/MF A01. Order Number DE83009924.

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In the presently existing formulation of the PILOT Process Integrated Model (PPIM) consumers can adjust the existing stocks of fuels utilizing devices so as to meet their demands for energy services at the lowest cost. Energy-services demands, however, are assumed to be non-responsive to prices. The consumers Energy Services Model (CESM) proposes a formulation in which energy-service demands are price responsive in addition to inter-fuel and capital-fuel substitutions which are allowed to take place through the stock adjustments. Thus the CESM accounts specifically for stock adjustments and penetration of new technologies and for consumers behavioral preference. It can be run as an integral part of the PPIM or in an independent mode as a model on its own.

29743 **(DOE/ER/72018—T4) Large-scale systems optimizations with application to energy. Technical report SOL 77-3.** Dantzig, G.B. (Stanford Univ., CA (USA). Systems Optimization Lab.). Apr 1977. Contract AT03-76ER72018;AT03-76EI70052. 20p. NTIS, PC A02/MF A01. Order Number DE83009889.

Research at Stanford's Systems Optimization Laboratory on solving large-scale dynamic linear programs is discussed, using the PILOT Energy Economic Model as a test example.

29744 **(DOE/ER/72018—T5) Convergence properties of a PIES-type algorithm for non-integrable functions. Technical report SOL 77-33.** Irwin, C.L. (Stanford Univ., CA (USA). Systems Optimization Lab.). Dec 1977. Contract AT03-76ER72018;AT03-76EI70052. 19p. NTIS, PC A02/MF A01. Order Number DE83009891.

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An algorithm for determining the market equilibrium in the presence of non-integrable but differentiable excess demand functions is developed. This can be reviewed as a variant of the Project Independence Evaluation System Algorithm. A sequence of approximate market equilibria are obtained by constructing integrable excess demand functions. Conditions for the existence and uniqueness of the solutions are demonstrated. It is shown further that the sequence converges to the true market equilibrium if a matrix related to the demand elasticities has a spectral radius less than one. There is a close analogy to known methods for iterative solution of nonlinear equations. Geometric interpretations and some effects of coordinate transformation are discussed.

29745 **(DOE/ER/72018—T6) Are dual variables prices, if not, how to make them more so. Technical report SOL 78-6.** Dantzig, G.B. (Stanford Univ., CA (USA). Systems Optimization Lab.). Mar 1978. Contract AT03-76ER72018;AT03-76EI70052. 17p. NTIS, PC A02/MF A01. Order Number DE83009890.

This paper shows how to make a simple perturbation to the linear program, after it has been solved, so that the new dual variables behave more like actual prices. To do this we will need three assumptions: the unused part of capacity is worth zero and can be deleted from the system; an infinitesimal ϵ part of the used capacity is malleable; and the value of capacity can be measured by deleting the malleable ϵ part and seeing what it is worth to put it back. We shall show that it is possible to associate new prices with the optimal solution to the perturbed linear program without changing the original optimal primal solution. The new prices remain invariant as the malleable ϵ part of used capacity tends to zero.

29746 **(DOE/ER/72018—T7) Stanford PILOT energy/economic model. Technical report SOL 77-19.** Connolly, T.J.; Dantzig, G.B.; Parikh, S.C. (Stanford Univ., CA (USA). Systems Optimization Lab.). Jul 1977. Contract AT03-76ER72018;AT03-76ER72018;AT03-76EI70052. 49p. NTIS, PC A03/MF A01. Order Number DE83009925.

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At the core of the project activity is the development of a multisector, intertemporal linear programming modeling system that describes in physical terms many of the technological interactions within and across the sectors of the American economy. The general aim of the modeling effort is to permit studies (1) to assess how specific energy policies will affect the energy supply/demand picture and (2) to assess how the physical capacity of the economy over the next 30 to 35 years to provide goods and services to its populace could be affected by changes in the energy supply picture. Intertemporal linear programming models of the energy sector and the economy provide a unique medium for exploring future energy policy options. This paper presents the first version of PILOT together with three illustrative scenarios. The model deficiencies and new developments in progress are briefly discussed.

2902 Economics And Sociology

REFER ALSO TO CITATION(S) 28978, 29030, 29297, 29492, 29734, 29738, 29742

29747 **(PB—83-151258) Coal from the nation: household demand for electricity. Staff report.** McKean, J.R.; Green, J.W. (Economic Research Service, Washington, DC (USA). Natural Resource Economics Div.). Jun 1982. 286p. NTIS, PC A13/MF A01.

This report summarizes the econometric theory surrounding estimation of residential demand functions and describes the methodology used to develop residential electricity demand functions for 136 utility service areas. A single equation function is described; its functional form is log-linear. Special treatment is given cost-of-living differences and climatic variables. The demand equations were estimated in two stages. The selected model contained humidity as a second weather variable, is adjusted for heteroskedasticity, and has all variables correct in sign and approximate magnitude. Elasticities are reported for income and prices and compared to previous studies. Price and income projections are then used to predict 1985 electricity sales.

29748 **(JPRS—80745) China report: economic affairs, No. 228. Energy: status and developments-IV.** (Joint Publications Research Service, Arlington, VA (USA)). 6 May 1982. Translation of various articles. 143p. NTIS.

A separate abstract was prepared for each of eight contributions for the Energy Data Base (EDB).

2903 Environment, Health, And Safety

REFER ALSO TO CITATION(S) 29773, 30348, 30349, 30526, 30532, 30586

29749 **(BNL—30736) Impact of energy and industrial pollution on public health.** Morris, S.C. III. (Brookhaven National Lab., Upton, NY (USA)). 1981. Contract AC02-76CH00016. 20p. (CONF-810219—4). NTIS, PC A02/MF A01. Order Number DE83010153.

From Symposium on the genotoxic effects of airborne agents; Upton, NY, USA (1 Feb 1981).

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Risk assessment studies on the epidemiology of neoplasms are reviewed. Conclusions are evident of an occupational relation, especially among workers exposed to chemical and industrial pollutants. Populations living within vicinity of these plants are at increased cancer risks, however low it may be. Policy makers still face uncertainty in the current state of knowledge and must balance societal costs and benefits. (PSB)

29750 **(BNL—30740) Incorporating oxidants in assessments of energy-related health effects.** Morris, S.C. (Brookhaven National Lab., Upton, NY (USA)). 1981. Contract AC02-76CH00016. 9p. (CONF-8110175—2). NTIS, PC A02/MF A01. Order Number DE83010849.

From Symposium on research needs for evaluation of health effects of toxic chemical waste dumps; Research Triangle Park, NC, USA (27 Oct 1981).

A health effects assessment is a documented, quantitative description of knowledge and uncertainty regarding the potential health impact of a program or policy action. Such assessments are useful in evaluating or formulating research and development in both the energy and environmental areas.

29751 **Model energy audit procedure for the RCS program.** Johnson, D.R. (Oak Ridge National Lab., TN); Olsen, K.O. pp 542-566 of Energy in the man-built environment. New York, NY; American Society of Civil Engineers (1981). Contract W-7405-ENG-26;AC02-77CH00178.

From Energy in the man-built environment; Vail, CO, USA (3 Aug 1981).

Individual papers are abstracted separately for the data base. Because of size limitations three papers given at the conference will appear in the Fall '82 issue of this journal. (PSB)

2904 Natural Resources

29752 **(CONF-810477—7) Analysis and estimation of a nonlinear storage-price model for steel scrap.** O'Neill, W.; Wolsky, A.; Gibbons, J.; Sparrow, F.T. (Argonne National Lab., IL (USA)). Apr 1981. Contract W-31-109-ENG-38. 20p. NTIS, PC A02/MF A01. Order Number DE83009559.

From 12. modeling and simulation conference; Pittsburgh, PA, USA (30 Apr 1981).

Linear consumption, production and market equilibrium sectors are postulated but replace the linear inventory-price equation with a nonlinear one whose assumed structure is consistent with the usual behavioral attributes assigned to this sector. The net result is a model capable of explaining the often cited volatility in steel scrap prices.

29753 **(DOE/EI/70052—T5) Decision under several objectives. Technical report SOL 77-20.** Jansen, P.J. (Stanford Univ., CA (USA). Systems Optimization Lab.). Aug 1977. Contract AT03-76EI70052. 70p. NTIS, PC A04/MF A01. Order Number DE83009895.

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Solutions of problems encountered in endogenous treatment of environmental aspects in an economic model are proposed for: (1) an aggregated environmental utility measure; (2) a method for achieving a compromise between economic and environmental goals; and (3) providing for feedback of abatement industries to the rest of the economy. Problems (1) and (2) are related to decision making under several objectives. The methodology is developed for an environmental utility function and demonstrated with an illustrative aggregate hazard (air pollution) index for each energy source of fossil power stations and nuclear power stations. The aggregate hazard index is the sum of the hazard indexes of various pollutants, computed from specific emissions and air quality norms for the pollutant. A compromise between economic and environmental goals is achieved by adding a constraint that provides a Pareto optimum type solution which best fulfills both goals as it requires equal degrees of satisfaction of an economist and an environmentalist.

29754 (LA—9479-PR, pp 135) Activities of the Los Alamos National Environmental Research Park, FY 81. Bostick, K.V. Oct 1982. NTIS, PC A08/MF A01.

In Los Alamos Life Sciences Division's biomedical and environmental research programs. Progress report, January-December 1981.

The Los Alamos National Environmental Research Park (LA/NERP) was established as a field laboratory for ecological research, to study the environmental impacts of energy development, and as a source of public information on environmental issues. The emphasis of research on the park is to develop criteria that facilitate energy development in ways that are least harmful to the environment. The requirements in the charter for the Life Sciences at Los Alamos National Laboratory also guide activities of the LA/NERP.

29755 (ORNL/PPA—82/6) Minerals in the eighties: issues and policies. An exploratory essay. Landsberg, H.H. (Oak Ridge National Lab., TN (USA)). Dec 1982. Contract W-7405-ENG-26. 68p. NTIS, PC A04/MF A01. Order Number DE83010404.

It is a poor economic climate for experimenting with collective production, trade and price manipulation. It is also a poor climate for domestic producers to invest exploration or domestic expansion in other ways, in recycling, in substitution research and development or in any other activity not directly aimed at economizing and raising the rate of earnings. It is therefore, a period in which Government initiatives are especially called for. One of them, acquisitions for the strategic stockpile, would be favored by the current - and probably protracted - lull in prices. Most minerals would correctly appear to be good buys. On the other hand, R & D initiatives are impeded by budget-cutting. The current Administration's belief that the market will pick up those government activities eliminated from a slimmed-down budget will probably be futile.

2905 Research, Development, Demonstration, And Commercialization

REFER ALSO TO CITATION(S) 28822, 29772, 29775

29756 (AERE-PR/TP—38) Progress report on physics and metallurgy, October 1980 - September 1981. (UKAEA Atomic Energy Research Establishment, Harwell. Theoretical Physics Div.). Mar 1982. 134p. NTIS (US Sales Only), PC A07/MF A01. Order Number DE83701533.

The report falls under the headings: nuclear, atomic and molecular physics (atomic and molecular theory; nuclear theory; centrifugal flow); theory of fluids (statistical mechanics; general fluid mechanics; flow in porous media; energy modelling); radiation damage and theoretical metallurgy (radiation damage; safety studies; mechanical and defect studies); theory of solid state materials (non-destructive testing; atomistic studies of defects in solids; atomistic studies of surfaces and planar defects; electronic structure of solids; studies of minerals and of vitrified waste).

29757 (NFL—31) Progress Report 1981. (Studsvik Science Research Lab., Nykoeping (Sweden)). 1982. 96p. NTIS (US Sales Only), PC A05/MF A01. Order Number DE83701505.

The facilities at the Studsvik Research Centre serve as a basis for fundamental research. The neutron diffraction work aiming at determining crystal structures has continued both with single crystals and powders in collaboration with university groups from Lund, Stockholm, Goeteborg and Uppsala. Results are reported for a number of compounds. The neutron scattering studies deal with liquid metals and elementary excitations in liquid ^{3}He. Another project is to equip a reactor channel with a Sc filter to produce nearly mehoenergetic neutron beams. The R2-0 reactor is used in the isotope-separator-on-line experiment OSIRIS. The main research activity has been connected to studies of the properties of short-lived neutron-rich isotopes of zinc, gallium, germanium, bromine, cadmium, indium and iodine. Thermal neutron induced fission of ^{235}U at OSIRIS and heavy-ion induced regetions are studied as a collaboration project with a group at Lawrence Barkeley Laboratory. The Van de Graaff-accelerator is used for experiments in elastic scattering from radiogenic Pb and ^{209}Bi, inelastic scattering from ^{89}Y and ^{141}Pr. The accelerator is also used for analytical determinations using the PIXE technique. The radiation chemistry group has continued the studies of primary reactions in crystalline organic materials using pulse radiolysis and ESR spectroscopy techniques. The kinetics of the decay of the ions is determined after irradiations with a pulsed 800 kV electron accelerator of type Febetron. The laboratory has been financially supported by the Natural Science Research Council and the Board of Technical Development. A description of research programs is given and list of publication is presented.

29758 (PB—81-183873) Federal funds for research and development, Fiscal years 1979, 1980, and 1981. Volume XXIX. Detailed statistical tables. (National Science Foundation, Washington, DC (USA). Div. of Science Resources Studies). Nov 1980. 187p. (NSF—80-318). NTIS, PC A09/MF A01.

These 128 detailed tables present data on R and D activities of Federal agencies for the 1979 to 1981 period by a number of breaks. They cover research and development by agency, character of work (basic research, applied research, and development) and performer, research by agency, performer and field of science; basic research, applied research, and development by agency and performer; total research, basic research and applied research performed at universities and colleges by agency. In addition, data are provided on foreign performers and the distribution of R and D obligations by state. Historical series for major categories for the 1971 to 1981 period are also given.

2906 Nuclear Energy

REFER ALSO TO CITATION(S) 29111, 29119, 29128, 29739, 30895

2907 Transport And Storage

REFER ALSO TO CITATION(S) 29705

2908 Waste Heat Utilization

REFER ALSO TO CITATION(S) 29500, 29501, 29502, 29503, 29504, 29505, 29506, 29507, 29508, 29509, 29510, 29511, 29512, 29513, 29514, 29821, 29823, 29824, 29825, 29833, 29837, 29841, 29842, 29844, 29845, 29847, 29848, 29849, 29853, 29854

29759 (CONF-811006—14) District heating via combined heat and power: a past and future comparison of Europe to the USA. Santini, D.J. (Argonne National Lab., IL (USA)). 1981. Contract W-31-109-ENG-38. 16p. NTIS, PC A02/MF A01. Order Number DE83009676.

From 3. international conference on energy use management; West Berlin, F.R. Germany (26 Oct 1981).

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This research examines seven conditions economically favorable to the implementation of combined-heat-and-power (CHP) district heating in downtown urban areas. The past, present, and future existence of these conditions in Western Europe and the US is assessed. It is demonstrated that sound economic reasons exist for the historical adoption of CHP district heating in Europe while district-heating languished in the US. It is argued that the conditions originally causing Europe to adopt CHP district heating are now present in much of the US and that the future trends on both continents will favor expansion of CHP district heating.

29760 **(EPRI-EA/EM—2893) EPRI cogeneration seminar: proceedings.** (Synergic Resources Corp., Bala-Cynwyd, PA (USA)). Feb 1983. 494p. (CONF-820777—). NTIS, PC A21/MF A01. Order Number DE83901876.

From EPRI cogeneration seminar; Berkeley, CA, USA (28 Jul 1982).

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Sixteen papers were presented at the meeting. A separate abstract was prepared for each paper. (LCL)

2910 Conservation

REFER ALSO TO CITATION(S) 29813, 29820, 29846

29761 **(AD-A—123673/6) EMCS cost estimating data. Final report May-Sep 82.** Cornelius, C. (Newcomb and Boyd Consulting Engineers, Atlanta, GA (USA)). Jan 1983. 35p. NTIS, PC A03/MF A01.

This report provides current cost estimating data for large, medium, and small EMCS. The report includes unloaded material and labor costs obtained from equipment manufacturers of system components. It also suggests factors to be used in determining total costs and provides samples of point cost deviations.

2920 Supply, Demand, And Forecasting

REFER ALSO TO CITATION(S) 28980, 29119, 29747

29762 **(DOE/ER/72018—T1) Long-run elasticity of energy demand. Technical report SOL 77-6.** Parikh, S.C.; Rothkopf, M.H. (Stanford Univ., CA (USA). Systems Optimization Lab.). Feb 1977. 35p. NTIS, PC A03/MF A01. Order Number DE83009929.

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The text of a pre-energy crisis study of the long-run elasticity of US energy demand performed for Shell Oil Company is presented. The study is presented for its qualitative as well as quantitative results, historical interest, and as an example of the use of a process analysis methodology for energy demand analysis.

29763 **(DOE/NBM—3010529) Estimating the short-term producibility of oil and gas.** (National Research Council, Washington, DC (USA). Committee on Producibility of Oil and Gas). 1983. 130p. NTIS, PC A07/MF A01. Order Number DE83010529.

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The following topics were addressed: the concepts of productive capacity used by others in the past, their attributes and facilities, and the development of recommended concepts likely to provide the most useful data to EIA; the data needed to develop estimates of productive capacity and the availability, accuracy, and properiety of such data; data-gathering and -analysis methods appropriate to EIA's need to obtain, analyze, and verify information on productive capacity; and the major constraints to and opportunities for increased domestic oil and gas production. A series of methodologies reasonably conservative of time, effort, and expense but that will provide reliable and useful estimates to agencies with responsibility for energy emergency preparedness are recommended. (PSB)

29764 **(NZERDC-P—73) Energy in the New Zealand household: the energy cost of living, 1974 to 1980.** Peet, N.J.; Carter, A.J.; Baines, J.T. (New Zealand Energy Research and Development Committee, Auckland). Nov 1982. 42p. NTIS, PC A03/MF A01. Order Number DE83901659.

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This project involved evaluation of those economically-traded forms of energy which are consumed in the home, either directly as fuel or indirectly embodied in the production of the goods and services that add up to material lifestyle. Data on expenditures were obtained from the Household Expenditure Survey of the Department of Statistics.

29765 **(ORAU/IEA—83-4(M)) Industrial electrification: current trends.** Burwell, C.C. (Oak Ridge Associated Universities, Inc., TN (USA)). Feb 1983. Contract AC05-76OR00033. 53p. NTIS, PC A04/MF A01. Order Number DE83010358.

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Trends in the uses of fuels and electricity in manufacturing are reviewed for the period 1974 to 1980. Electrification is observed in the manufacture of iron and steel, nonferrous metals, glass, cement, paper, and petroleum products. The incentive for electrification is outlined in terms of the quality (i.e., temperature) of energy requirements and the degree to which particular manufacturing sectors were already electrified in 1974. Technical bases for recent trends in electrification are discussed briefly.

2930 Policy, Legislation, And Regulation

REFER ALSO TO CITATION(S) 29261, 29751, 31015

29766 (CONF-820273—, pp 7p, Paper 1) **World energy crisis.** Ray, D.L. 1982. Resource Development Council for Alaska, 444 West 7th Ave., Box 516, Anchorage, AK $30.00.

From 2. Alaska coal marketing conference; Anchorage, AK, USA (18 Feb 1982).

The author dates the perception of the most recent energy crisis to the withholding of Mid-East oil from the world market in 1973. But people have worried about supplies of energy and raw materials in the past and been proved wrong (Mathus, Jevons, etc.). The author is worried in particular about fuel for tractors to provide food and points out with reasons why we cannot go back to horses. She considers several significant factors: (1) Energy costs are now much higher; (2) the question of available supplies is somewhat uncertain but the energy reserves of natural gas, heavy crude oil, oil shales and tar sands are enormous; but the rich, easily recovered deposits are limited and spotty in distribution; (3) access to these deposits is complicated by politics and government policies; (4) concerns about security; and (5) the final problem is that of public perception of relative risk involved (here she feels that nuclear energy has failed to educate the public). The author points out that fossil fuels and fission fuels were not used during most of man's civilized existence on this planet and considers in particular the major changes in agriculture in America in the last 50 years. (LTN)

29767 (CONF-820273—, pp 7p, Paper 14) **California Energy Commission policy affiliation.** Schweickart, R.L. (California Energy Commission, Sacramento). 1982. Resource Development Council for Alaska, 444 West 7th Ave., Box 516, Anchorage, AK $30.00.

From 2. Alaska coal marketing conference; Anchorage, AK, USA (18 Feb 1982).

Today the California energy scene is dominated by oil and gas, especially oil. Of the 1200 MBOE (million barrels of oil equivalent) of total energy used in California in 1980, fully 91 percent or 1100 MBOE were oil, natural gas or natural gas liquids. An annual state consumption of 10 billion gallons of gasoline demand. This dependence on petroleum for virtually 100 percent of our transportation in California spells vulnerability and disruption as we found out in 1974 and again in 1979. A final factor of note in the California energy scene, and one especially relevant to coal use, is

California's air quality environment. Our utility bills are going out of sight since over 2/3 of our electricity is generated from oil and natural gas. From these analyses we have identified a set of priorities for future electricity supplies which form the basis of California energy policy. Demand reducing measures such as conservation, load management, solar energy and utility power pooling are highest in our priority list. Stimulated by the 1979 oil crisis, the California Energy Commission began seriously looking at alternatives to petroleum for transportation. The Energy Commission began a series of analysis and hardware projects which have now been integrated into our Clean Alternatives Liquid Fuels (CAL Fuels) Program. We have a great deal of data and hard experience which have emerged from these projects, but to cut through it all to the bottom line, relief is spelled M-E-T-H-A-N-O-L.

29768 **(DOE/CS/69160—T4) Information and training program for state and regional SLAP organizations. Final report, February 1, 1981-January 31, 1983.** Spak, G.T. (New York Inst. of Tech., Old Westbury (USA). Center for Energy Policy and Research). 22 Mar 1983. Contract FG03-81CS69160. 36p. NTIS, PC A03/MF A01. Order Number DE83009346.

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Under a contract from DOE, effective between 1978 and January 1981, the Center for Energy Policy and Research of New York Institute of Technology provided a monthly package of energy information (INFO EES) to lead officials in state and territory Energy Extension Service and State Energy Conservation Program offices as well as to DOE-designated officials from headquarters, regional offices and the Technical Information Center. Effective February 1981 under a two-year grant arrangement with DOE the service was modified to broaden distribution of materials to also include lead officials in each state and territory associated with Institutional Conservation Program, and the Weatherization Assistance Program. Two training seminars for state employees were held; and training manuals were produced and distributed. (PSB)

29769 **(DOE/EIA—0173(82)) 1982 annual report to Congress.** (USDOE Energy Information Administration, Washington, DC). Apr 1983. 84p. NTIS, PC A05/MF A01. Order Number DE83009853.

The format of this annual report has been condensed to one volume for discussing the agency's responsibilities and accomplishments. Summaries of energy data and projections will now be issued separately in reference form. Appendices include: surveys of EIA; models of the EIA; and publications of EIA. (PSB)

29770 **(DOE/IG—0008/3) 1982 annual report, Office of Inspector General.** (Department of Energy, Washington, DC (USA). Office of Inspector General). Mar 1983. 63p. USDOE-TIC, PO Bx 62, Oak Ridge, TN 37830.

The report begins with a summary of the activities of the inspector general's office during Calendar Year 1982. This is folowed by a section dealing with the problems uncovered, recommendations for correcting them, and the progress made by the Department in making the recommended adjustments. The section is divided into three parts - Audit Activities, Inspection Activities and Investigative Activities. The fourth section discusses other significant IG activities that occurred during the calendar year. Following this are two appendixes. Appendix A covers recommendations in public reports over six months old as of December 31, 1982, on which corrective action is not complete. Appendix B lists all reports issued by the Inspector General during 1982, chronologically by division - Audits and Inspections.

29771 **(DOE/RG—0057/2) Powerplant and Industrial Fuel Use Act. Annual report.** (USDOE Economic Regulatory Administration, Washington, DC. Office of Fuels Programs). 1 Mar 1983. 32p. NTIS, PC A03/MF A01. Order Number DE83010617.

This annual report has been prepared for Congress by the Department of Energy in conjunction with the Environmental Protection Agency, as required by section 806 of the Powerplant and Industrial Fuel Use Act of 1978 (FUA) as amended, Public Law 95-620, enacted November 9, 1978. This annual report describes actions taken, under the provisions of the legislation, to encourage the use of indigenous energy resources in electric powerplants and major fuel-burning installations in the electric utility, industrial, and Federal governmental sectors. This report addresses implementation activities during calendar year 1982 under FUA and section 2 of the Energy Supply and Environmental Coordination Act of 1974, Public Law 93-319, and assesses the effectiveness of both laws in achieving their purposes. The report also includes summary information on natural gas consumption by electric utilities in 1977 and 1982, as required by section 711(c) of FUA, as amended by section 1021 of the Omnibus Budget Reconciliation Act of 1981, Public Law 97-35. Copies of this report were submitted to the Committee on Energy and Natural Resources of the US Senate and to the Committee on Energy and Commerce of the US House of Representatives, as required by section 807 of FUA. A companion report, as required by section 403(c) of FUA, will be submitted to Congress covering implementation of FUA at fuel-burning facilities owned or operated by the Federal Government.

29772 **Promoting Federal efficiency.** Hollander, E. (EPRI, Washington, DC). *EPRI (Electric Power Research Institute) Journal;* 8: No. 1, 28-31(Jan-Feb 1983).

The author interviewed Dexter Peach of the General Accounting Office (GAO) who explained that the GAO selects areas of concern that show emerging issues of interest to Congres and where GAO audits will be most effective. If the GAO correctly anticipates energy issues, it can more effectively respond to congressional requests for information. The GAO strategic plan targets 14 issues of interest to the electric-utility industry, e.g., (1) the effectiveness of nuclear power regulation since Three Mile Island, and (2) the administration's philosophy of encouraging a private-sector role in energy research and development. Peach cites fluidized-bed combustion as a promising technology, and outlines GAO's plans to survey supply and demand information and its report on DOE dismantlement. (DCK)

2940 Fossil Fuels

REFER ALSO TO CITATION(S) 28822, 28898, 28945, 28971, 28972, 28978, 28980, 28983, 28986, 29050, 29055, 29496, 29767, 29771

29773 **(CONF-830226—1) Environmental implications of synfuel development.** DeCicco, S.G. (Oak Ridge National Lab., TN (USA)). 25 Feb 1983. Contract W-7405-ENG-26. 16p. NTIS, PC A02/MF A01. Order Number DE83009651.

From 10. WATTEC annual energy conference; Knoxville, TN, USA (25 Feb 1983).

The synthetic fuel industry is perhaps the only industry ever to be subjected to a nationwide review of potential environmental consequences before the first commercial scale plant is built. The first wave of synfuel plants will continue to be scrutinized by a suspicious public that has witnessed a decade of increasing environmental regulation, Three Mile Island, and Love Canal. The EPA will not be issuing pollutant discharge limits for synfuel facilities in the near future. Instead, the first plants will be regulated on a case-by-case basis using the environmental permit system. In general, synfuel plants should be capable of complying with applicable environmental standards by adapting commercial pollution control technology. There should be no acute environmental impacts from a properly suited, designed, and controlled plant. However, because no commercial-scale plants exist for most synfuel technologies, many environmental questions remain unanswered. The major questions deal with: (1) the long-term effects on workers and the environment of low-level exposure to synfuel chemicals; (2) the characteristics of actual gaseous, liquid, and solid waste from large-scale facilities; and (3) the adaptability effectiveness, and reliability of commercially available pollution control technology. Specific issues relate to the need for quantitative health risk assessments, the implications of the Toxic Substances Control Act, the practicality of the mandate for zero wastewater discharge, the control of fugitive hydrocarbon emissions, the effects of solid waste disposal, and the cumulative impacts of regional energy development (especially socioeconomics). Environmental monitoring will play a large role in understanding the technologies, characterizing pollutants and the effectiveness of control technology, developing realistic environ-

mental standards, and determining the effects of synfuel chemicals on workers and the environment.

29774 **(DOE/EIA—0130(83/03)) Natural gas monthly.** (USDOE Energy Information Administration, Washington, DC. Office of Oil and Gas). Mar 1983. 95p. NTIS, PC A05/MF A01. Order Number DE83010282.

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Current data are presented on the consumption, disposition, production, prices, storage, import, and export of natural gas in the United States. Also included are operating and financial data for major interstate natural gas pipeline companies plus data on filings, ceiling prices, and transportation under the Natural Gas Policy Act of 1978.

2960 Electric Power

REFER ALSO TO CITATION(S) 29297, 29492, 29496, 29503, 29504, 29505, 29506, 29507, 29508, 29509, 29510, 29511, 29512, 29513, 29514, 29516, 29523, 29524, 29747, 29760, 29855

29775 **Decade of change: EPRI and the climate for research.** Barker, B. *EPRI (Electric Power Research Institute) Journal;* 8: No. 1, 4-13(Jan-Feb 1983).

The Electric Power Research Institute (EPRI) evolved into a more far-ranging force than its founders envisioned 10 years ago. Planning for an uncertain future will be one of the most-compelling lessons for an industry that traditionally plans in terms of decades. EPRI's role will be in helping to stabilize the political field of energy development, to rethink the push for new generating facilities as the best way to meet demand, and to encourage technology transfers. Three articles outlining the forces of change in the electric-power industry, the changing conditions of the world energy structure, and the challenges of meeting new social and industrial needs emphasize EPRI's emerging role as consultant and leader as well as a technical resource. (DCK)

29776 **Introduction of non-dispatchable technologies as decision variables in long-term generation expansion models.** Caramanis, M.C.; Tabors, R.D.; Nochur, K.S.; Schweppe, F.C. (MIT, Cambridge, MA, USA). pp 9p, Paper 82WM 008-1 of IEEE Power Engineering Society winter meeting. New York, NY; IEEE (1982).

From IEEE Power Engineering Society winter meeting; New York, NY, USA (30 Jan 1982).

Non-dispatchable technologies (solar, wind, run-of-the-river hydro, cogeneration) affect the cost of electricity production in a complex manner by modifying the probability distribution of demand for conventional dispatchable generation (thermal, hydro, central storage, etc.). The lack of an appropriate methodology to efficiently drive this modification has prevented inclusion of non-dispatchable technologies as decision variables in capacity expansion models. This paper develops a stochastic approach to load modification which explicitly models two types of interdependencies between load and non-dispatchable generation: through time of day and through weather. If more than one non-dispatchable generation technology is considered, the dependency among them is also modeled. Furthermore, the total as well as the marginal impact on non-dispatchable capacity on system reliability and operating cost is derived. This allows us to model non-dispatchable generation in the context of two broad classes of optimization algorithms. Dynamic programming and mathematical decomposition are considered in this papers as characteristic examples of algorithms in each class. The methodology developed here provides marginal impact in addition to total impact valves, is computationally efficient and is applicable to future demand very satisfactory when tested on 1975 Miami load and insolation data. 10 refs.

29777 **Optimal spot pricing: practice and theory.** Caramanis, M.C.; Bohn, R.E.; Schweppe, F.C. (MIT, Cambridge, MA, USA). pp 12p, Paper 82WM 215-4 of IEEE Power Engineering Society winter meeting. New York, NY; IEEE (1982).

From IEEE Power Engineering Society winter meeting; New York, NY, USA (30 Jan 1982).

Spot pricing is an approach to electric power systems pricing which does away with concepts such block rate, demand charges, back-up charges, capacity credits, and so on. Instead, an energy marketplace for electric power is established. The spot price for buying and selling electric energy is detemined by the supply and demand conditions at that instant. Optimal spot pricing is desirable because it improves the efficiency of the electric power system. It can give higher profits for both the utility and its customers. Examples of the impacts of optimal spot pricing include: Reduction of oil consumed in generation by raising prices explicitly whenever oil is being used. Removal or reduction of the need for rotating blackouts to handle emergency generation shortage situations, by using prices to give an automatic socially efficient rationing system. Enhancement of and integration of wind, solar, and customer-owned cogeneration into the grid by providing an energy marketplace which values energy at its "true" value. Variable charges, back-up charges, and capacity credits are not needed. Providing a vehicle for partial or, perhaps, complete deregulation of generation, if that is deemed desirable. 15 refs.

2980 Consumption And Utilization

REFER ALSO TO CITATION(S) 29764, 29774, 29816, 29835

2990 Unconventional Sources And Power Generation

REFER ALSO TO CITATION(S) 29337, 29351, 29850, 29851, 29852, 29856

30 DIRECT ENERGY CONVERSION

3001 Mhd Generators

29778 **(CONF-810639—7) Three-dimensional MHD electrical boundary approximations and applications.** Zwick, S.A.; Doss, E.D.; Pan, Y.C.; Shamma, S.E. (Argonne National Lab., IL (USA)). 1981. Contract W-31-109-ENG-38. 11p. NTIS, PC A02/MF A01. Order Number DE83009339.

From 19. symposium on the engineering aspects of magnetohydrodynamics; Tullahoma, TN, USA (15 Jun 1981).

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Analytical methods are developed for calculating the potential and currents near boundary singularities caused by electrodes edges or abrupt drops inconductivity σ or in the induction field uB. A three-dimensional control volume (finite-difference) model for solving the MHD electrical problem in oblique coordinates; has been developed, which accounts for the near-wall singular behavior accurately and can be used with relatively sparse grids. Analyses based on the model indicate that, for practical generator design where the electrode pitch is in the order of 1 to 5 cm and the wall temperature less than 2100 K, the performance of diagonal conducting wall (DCW) channels is always superior to that of channels with insulating sidewalls, although the performance of insulating sidewall channel is better at higher wall temperatures. Sidewall electrode extensions up to a wraparound of about 20% of the channel height are shown to cause an increase in power output. The power output of diagonally connected channels remains approximately the same for more than 20% wraparound; whereas the power output of Faraday channels drops off with further extensions of the sidewall conductors.

29779 **(CONF-820645—9) Design characteristics of an MHD radiant-boiler experiment.** Chow, L.S.H.; Bailey, J.L. (Argonne National Lab., IL (USA)). 1982. Contract W-31-109-ENG-38. 7p. NTIS, PC A02/MF A01. Order Number DE83010727.

From 20. symposium on engineering aspects of magnetohydrodynamics; Los Angeles, CA, USA (14 Jun 1982).

The critical design issues of an MHD radiant boiler are radiant heat transfer, nitric oxide decomposition, seed-slag interaction and separation, and material erosion and corrosion. In addition, the effects of the topping cycle operating conditions and boiler inlet configuration on these design issues must be determined. Because conventional design methods are probably not accurate enough for the MHD conditions, experiments are required to provide engineering data to investigate these issues and to design large components

to meet system requirements. The parameters governing the critical design issues and how they could be measured in a carefully designed test apparatus and the instrumentation required will be discussed in this paper. When the experiments and the test apparatus are designed with assistance from analytical models and when the test data are interpreted accordingly, the test data can be scaled-up and used for the design of large prototype MHD radiant boilers.

29780 (DOE/NASA/0136—1) **Parametric analysis of closed-cycle magnetohydrodynamic (MHD) power plants.** Owens, W.; Berg, R.; Murthy, R.; Patten, J. (Gilbert Associates, Inc., Reading, PA (USA)). Sep 1981. Contract AI01-77ET10769. 282p. (NASA/CR—165472). NTIS, PC A13/MF A01. Order Number DE83010894.

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A Parametric Analysis of Closed Cycle MHD Power Plants was performed which studied the technical feasibility, associated capital cost, and cost of electricity for the direct combustion of coal or coal derived fuel. Three reference plants, differing primarily in the method of coal conversion utilized, were defined. Reference Plant 1 used direct coal-fired combustion while Reference Plants 2 and 3 employed on-site integrated gasifiers. Reference Plant 2 used a pressurized gasifier while Reference Plant 3 used a state-of-the-art atmospheric gasifier. Thirty plant configurations were considered by using parametric variations from the Reference Plants. Parametric variations include the type of coal (Montana Rosebud or Illinois No. 6), clean-up systems (hot or cold gas clean-up), one- or two-stage atmospheric or pressurized direct-fired coal combustors, and six different gasifier systems. Plant sizes ranged from 100 to 1000 MWe. Overall plant performance was calculated using two methodologies. In one task, the channel performance was assumed and the MHD topping cycle efficiencies were based on the assumed values. A second task involved rigorous calculations of channel performance (enthalpy extraction, isentropic efficiency and generator output) that verified the original (task one) assumptions. Closed cycle MHD capital costs were estimated for the task one plants; task two cost estimates were made for the channel and magnet only.

3003 Thermoelectric Generators

REFER ALSO TO CITATION(S) 29284, 29379, 29380

29781 (AD-A—123264/4) **Engineering assessment of TEG and TEG/FC technology growth potential. Phase I. Engineering assessment of existing thermoelectric generator technology. Final report Jun-Sep 81.** Lee, W.D.; Long, R.G. (Little (Arthur D.), Inc., Cambridge, MA (USA)). Sep 1981. 63p. NTIS, PC A04/MF A01.

An analysis of the likely conformance of current thermoelectric generators to the Army SLEEP ROC is provided. A feasibility analysis of the thermoelectric generator as a means of providing electricity, heating and cooling to a typical mobile teletype terminal is given. Findings relative to the thermoelectric generator as a candidate for the SLEEP ROC and as a primary energy source for a teletype terminal are given.

29782 (SERI/CP—234-1577, pp 109-142) **High efficiency thermoelectric conversion with solid electrolytes-theoretical analysis.** Cole, T. (California Inst. of Tech., Pasadena, CA). 1981. NTIS, PC A11/MF A01.

From Thermo regenerative electrochemical systems workshop; Alexandria, VA, USA (3 Dec 1981).

A new type of thermally regenerative electrochemical system based on the unique electrochemical properties of the beta-alumina solid electrolytes (BASE) and referred to as the Sodium Heat Engine (SHE) or somewhat more descriptively as the Alkali Metal Thermoelectric Converter (AMTEC), is discussed. The AMTEC is a liquid-vapor concentration cell in which the working fluid sodium (or other alkali metal), is expanded approximately isothermally across a BASE membrane in a continuous cyclic process. The work output is electrical, no chemical regeneration of the working fluid is required and its efficiency is independent of size. As will be shown below the efficiency of the AMTEC should be in the range of 20 to 40% in optimized designs. This review will deal with the basic thermodynamics and transport processes taking place in the AMTEC, basic operating equations are given that can be used to predict the operating characteristics of practical devices.

29783 (SERI/CP—234-1577, pp 143-147) **Sodium heat engine, thermally regenerative electrochemical conversion with solid electrolytes.** Hunt, T.K.; Weber, N. (Ford Motor Co., Dearborn, MI). 1981. NTIS, PC A11/MF A01.

From Thermo regenerative electrochemical systems workshop; Alexandria, VA, USA (3 Dec 1981).

The Sodium Heat Engine (SHE) is a new device for direct thermoelectric conversion. It uses beta"-alumina solid electrolyte (BASE) to form a high temperature, thermally regenerative concentration cell for elemental sodium. The SHE has no moving parts, a small quantity of sodium as its single recirculating working fluid and its efficiency, which should reach 25 to 45% is virtually independent of size above a few watts. Results of current-voltage and efficiency experiments using test cells up to 100 cm^2 are reported. Conversion efficiency of 19% at 805°C and at power levels in the range of 20 to 30 watts has been achieved for a laboratory test cell employing 110 cm^2 of active surface area. A number of metal electrodes including Mo, Nb, W and Mo-Ti alloys, when tested in the SHE mode, exhibit an extremely low polarization at their interface with sodium beta"-alumina. Apparent interfacial impedances as low as 0.02 to 0.04 ohm-cm^2 are observed at the sodium and permeable metal electrode interfaces with sodium BASE.

3005 Fuel Cells

REFER ALSO TO CITATION(S) 29722, 30063

29784 (CONF-821141—3) **Development of cathode materials for the molten-carbonate fuel cell.** Sim, J.W.; Kucera, G.H.; Smith, J.L.; Breindel, A.M.; Pierce, R.D. (Argonne National Lab., IL (USA)). 1982. Contract W-31-109-ENG-38. 6p. NTIS, PC A02/MF A01. Order Number DE83009645.

From National Fuel Cell seminar; Newport Beach, CA, USA (14 Nov 1982).

The current emphasis of molten-carbonate fuel-cell research at Argonne National Laboratory is on developing cathode materials with better long-term stability than lithiated nickel oxide, which dissolves at the cathode and precipitates as nickel metal within the electrolyte tile. A methodology for evaluating candidate cathode materials has been adopted, and several materials have been prepared and tested for conductivity and short-term (<100 h) stability. The methodology and the preliminary results of materials testing are presented. Also, because the solubility of cathode materials in molten carbonates affects their long-term stability, techniques for determining solubility have been developed; the results of measurements on nickel oxide are presented.

29785 (CONF-830508—12) **Electronic conductivity of Li_2MnO_3 doped with aluminum, magnesium, or zinc.** Kucera, G.H.; Sim, J.W.; Smith, J.L. (Argonne National Lab., IL (USA)). 1983. Contract W-31-109-ENG-38. 2p. NTIS, PC A02/MF A01. Order Number DE83009609.

From Electrochemical Society meeting; San Francisco, CA, USA (8 May 1983).

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Because Li_2MnO_3 is chemically stable in highly basic solvents, it warrants consideration as a starting material for electrode (cathode) development in such systems as the molten carbonate fuel cell and the magnetohydrodynamic (MHD) power generation system. Stoichiometric Li_2MnO_3, a nonconductor, can be converted into an electronic semiconductor with the use of dopants. In this study, porous sintered samples of aluminum-, magnesium-, and zinc-doped Li_2MnO_3 were prepared, and the effects of dopant concentration and sintering temperature on electrical conductivity were examined. In addition, tests were performed to determine whether aluminum- and magnesium-doped Li_2MnO_3 are stable in 62 mol % Li_2CO_3-38 mol % K_2CO_3 eutectic at 925 K for a possible molten carbonate fuel cell application.

29786 **(DOE/CH/10124—T1) Fabrication of planar solid-oxide fuel cells. Final report, October 1982-February 1983.** Morse, T.F.; Seymour, W.C. (Montana Energy and MHD Research and Development Inst., Inc., Butte (USA)). 1983. Contract AC02-82CH10124. 38p. NTIS, PC A03/MF A01. Order Number DE83010996.

The goal of this work has been to explore and develop techniques for developing a planar Solid Oxide Fuel Cell (SOFC) technology. The work centered on the development of techniques for developing thin, yttria-stabilized zirconia electrolytes with an associated support structure. To make the above mentioned goal more meaningful a conceptual model of a SOFC was developed to provide modeling goals for the needed fabrication capability. Progress is reported. (WHK)

29787 **(LBL—15716) Transition-metal-oxide coated titanium electrodes for redox batteries. Final report.** Savinell, R.F. (Lawrence Berkeley Lab., CA (USA)). Dec 1982. Contract AC03-76SF00098. 56p. NTIS, PC A04/MF A01. Order Number DE83011035.

A primary motivation for this work was to produce porous electrodes (of titanium) with reproducible surface activity for experiments to corroborate predictions of porous electrode theory. An additional goal of this research program was to ascertain if simple one-step outer-sphere electron transfer mechanism applies to the ferric-ferrous redox reaction at high reactant/product concentrations in a strong acid chloride medium. Kinetic rate expressions of this couple under these conditions at the metal oxide surfaces were sought. Coatings of the conductive and active rutile structure form of selected transition metal oxides (namely RuO_2, IrO_2, OsO_2) were desired. Both IrO_2 and RuO_2 coatings having the rutile structure (as confirmed by x-ray diffraction) were prepared by thermal decomposition of their respective hydrated chloride salts. In the case of OsO_2 only amorphous coatings have been achieved. Low over potential exchange current densities of the ferric-ferrous couple were measured in concentrated solution (0.5 M Fe^{2+}, 0.5 M Fe^{3+}, 1 M HCl) at Pt, RuO_2 and IrO_2 RDE's. Significant corrections were necessary for ohmic effects, mass transfer effects, and nonuniform current distribution. The data show that the electrocatalytic activity of RuO_2 ($k_s = 1.92 \times 10^{-3}$ cm/s) is comparable to that of Pt ($k_s = 1.42 \times 10^{-3}$ cm/s) while the activity of IrO_2 ($k_s = 1.21 \times 10^{-4}$ cm/s) is approximately an order of magnitude less than Pt. Since the measured free energy of activation was similar for all three substrates (5.4 to 5.8 Kcal/mole), a nonbinding interaction between the couple and the surfaces is suggested. The variation in exchange currents among the different substrates can be attributed to some extent on double layer effects but primarily to crystal structure differences.

29788 **(PB—83-167270) Metal chelate catalysts for fuel cells. Final report June 1979 - October 1982.** Darby, R.; Yamana, M.; Dhar, H.; White, R. (Texas A and M Univ., College Station (USA). Dept. of Chemical Engineering). Oct 1982. 84p. NTIS, PC A05/MF A01.

Various modified forms of several organometallic chelate compounds were synthesized and tested for their activity and stability as oxygen reduction electrocatalysts in sulfuric acid electrolyte. The most active catalysts found were cobalt tetraazaannulene (CoTAA), iron phthalocyanine (FePc) and cobalt tetraphenylporphyrin (CoTPP). However, these catalysts have limited stability in strong acids.

29789 **(SAND—83-7001) Rechargeable alkaline zinc/ferricyanide battery, Phase III. Final report, 26 October 1981-18 September 1982.** Adams, G.B.; Hollandsworth, R.P.; Webber, B.D. (Lockheed Missiles and Space Co., Palo Alto, CA (USA). Research Labs.). Feb 1983. 171p. NTIS, PC A08/MF A01. Order Number DE83010615.

Project effort was concentrated primarily on technical advancement of the alkaline zinc/ferricyanide battery to meet goals of scale-up and demonstration of solid-reactant storage with 1000-cm^2 full-scale cells; development of a conceptual engineering design for a 50-kW solar-photovoltaic storage system; demonstration of solar acceptance random cycling; and determination of cycle life of cells operating at 70- and 200-mA.h/cm^2 capacity. These goals were met in the design, fabrication, and cyclic testing of a 1000-cm^2 cell having a flow aspect ratio of 2:1. After some design optimization, energy efficiency in 2N NaOH at 43°C is 74 to 78 percent. Testing has been in conjunction with a crystallizer/reservoir designed with a capacity of 300 mA.h/cm^2 that delivers solids-free electrolyte to the cell. A conceptual engineering design for a 50-kW solar storage-battery system has been formulated with mass and thermal balances computed. Single-cell (60-cm^2) cycle life tests are in progress at 35 mA/cm^2 with 2N NaOH electrolyte with Nafion N-125 separator at 40°C. Over 800 cycles at 70 mA.h/cm^2 capacity with mean energy efficiency of 76.6 +- 2.1 percent have been logged. Mean voltaic and coulombic efficiencies are 83.3 +- 1.8 percent and 92.0 +- 1.8 percent, respectively. Single-cell (60-cm^2) cycle life tests run under similar conditions at 249 +- 45 mA.h/cm^2 have logged over 220 cycles with mean energy efficiency of 75.3 +- 5.1 percent. Mean voltaic and coulombic efficiencies are 84.7 +- 2.0 and 89.0 +- 6.0, respectively.

29790 **(SERI/CP—234-1577) Thermally regenerative electrochemical systems workshop. Proceedings.** Chum, H.L. (ed.). (Solar Energy Research Inst., Golden, CO (USA)). 1981. Contract AC02-77CH00178. 249p. (CONF-811258—). NTIS, PC A11/MF A01. Order Number DE83002097.

From Thermo regenerative electrochemical systems workshop; Alexandria, VA, USA (3 Dec 1981).

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Separate abstracts were prepared for the 13 papers presented. Also, a panel discussion on the problems and prospects of Thermally Regenerative Electrochemical Systems is included. (WHK)

29791 (SERI/CP—234-1577, pp 31-45) **Introduction to the types of thermally regenerative electrochemical systems.** Chum, H.L. (Solar Energy Research Inst., Golden, CO). 1981. NTIS, PC A11/MF A01.

From Thermo regenerative electrochemical systems workshop; Alexandria, VA, USA (3 Dec 1981).

The seven types of thermally regenerative electrochemical systems are described and typical examples are tabulated. (WHK)

29792 (SERI/CP—234-1577, pp 159-176) **Iron (II) chloride electrochemical heat engine process including long-term electrochemical energy storage.** Salmon, O.N. (Industrial & Consumer Sector Research Lab., St. Paul, MN). 1981. NTIS, PC A11/MF A01.

From Thermo regenerative electrochemical systems workshop; Alexandria, VA, USA (3 Dec 1981).

An electrochemical heat engine process is described in which the reaction, $3FeCl_2$ reversible Fe + $2FeCl_3$, is driven to the right by supplying heat and electrical energy to an electrochemical cell containing fused chloride electrolyte above 500°C. The products, Fe and $FeCl_3$, can be stored separately and when electrical energy is needed, can be recombined by the reverse reaction in an electrochemical cell below 330°C. The output voltage generated by the reverse reaction at the lower temperature is larger than the input voltage required to cause of the forward reaction to take place at the higher temperature. Thus net electrical energy is produced in each complete cycle and the source of this energy is the heat absorbed during the forward reaction. The cause the favorable voltage effect is a large positive entropy change in the forward reaction because the $FeCl_3$ is generated as a gas. Due to the large entropy change, the cell regeneration voltage decreases rapidly with cell temperature at a rate of about -2.3 mV/°C thus resulting in good thermal coupling. With further development, it may be possible to achieve an overall heat to electrical energy conversion efficiency of 0.25 to 0.30, including long-term electrochemical energy storage, at cell power densities greater than 40 mw/cm^2. The process uses only abundant elements thus making possible very extensive electrochemical energy storage (e.g. seasonal) at reasonable cost.

29793 (SERI/CP—234-1577, pp 207-226) **Cu(I)/acetonitrile electrochemical heat engine.** Loutfy, R.O.; Brown, A.; Meisenhelder, J.; Yao, N.P. (Argonne National Lab., IL). 1981. NTIS, PC A11/MF A01.

From Thermo regenerative electrochemical systems workshop; Alexandria, VA, USA (3 Dec 1981).

Thermally regenerative electrochemical systems (TRES) or fuel cells are very similar to secondary batteries except that regeneration of the electrochemically active electrode reactants is accomplished thermally rather than electrically. The objective of the work reported was to develop a TRES that is capable of utilizing low grade heat (< 200°C) such as that from industrial waste heat, low temperature solar collectors such as the Argonne parabolic collector, and the bottoming cycles of utility plants. This system should also be capable of storing the heat energy in chemical form of high volummetric energy density until required. Based on work we have been doing at Argonne on the stabilization of lower-than-normal metal ion valence states for application in industrial electrolytic metal refining operations, we have developed a prospective TRES that meets the low temperature (< 200°C) regeneration requirement. This system is described.

29794 **Fuel cells for electric utility and transportation applications.** Srinivasan, S. (Brookhaven Natonal Lab., Upton, NY). *Proceedings of the Fifth Australia Electrochemistry Conference;* 1-22(1980).

This review article presents: the current status and expected progress status of the fuel cell research and development programs in the USA, electrochemical problem areas, techno-economic assessments of fuel cells for electric and/or gas utilities and for transportation, and other candidate fuel cells and their applications. For electric and/or gas utility applications, the most likely candidates are phosphoric, molten carbonate, and solid electrolyte fuel cells. The first will be coupled with a reformer (to convert natural gas, petroleum-derived, or biomass fuels to hydrogen), while the second and third will be linked with a coal gasifier. A fuel cell/battery hybrid power source is an attractive option for electric vehicles with projected performance characteristics approaching those for internal combustion or diesel engine powered vehicles. For this application, with coal-derived methanol as the fuel, a fuel cell with an acid electrolyte (phosphoric, solid polymer electrolyte or super acid) is essential; with pure hydrogen (obtained by splitting of water using nuclear, solar or hydroelectric energy), alkaline fuel cells show promise. A fuel cell researcher's dream is the development of a high performance direct methanol-air fuel cell as a power plant for electric vehicles. For long or intermittent duty cycle load leveling, regenerative hydrogen-halogen fuel cells exhibit desirable characteristics.

3008 Miscellaneous Converters

REFER ALSO TO CITATION(S) 29790, 29791

29795 **(DOE/ER/01736—T3) Demonstration of scientific and economic feasibility of a solid-state heat engine. Final report, November 7, 1977-September 30, 1982.** Olsen, R.B. (Power Conversion Technology, Inc., San Diego, CA (USA)). 1982. Contract AC03-78ER01736. 246p. NTIS, PC A11/MF A01. Order Number DE83009316.

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The use of the pyroelectric effet as a means for direct conversion of heat to electrical enrgy has been studied. Initial work concentrated on the Drummond-Carnot approach; later work focused upon a regenerative electric Ericsson approach. Demonstrated output power was raised from a previous high of 30 microwatts to 1 milliwatt, then 40 milliwatt, and then finally to 1.6 Watt (33 Watt/per liter of active pyroelectric) in separate experiments. Previous experiments had conversion efficiencies of roughly 0.001% (calculated). The 1.6 Watt device had a measured efficiency of 0.5% which is approximately one-tenth of the thermodynamic ideal (Carnot) limit. The active material for these pyroelectric conversion experiments was ceramic lead zirconate modified with Sn^{4+} and Ti^{4+} $Pb_{.99}Nb_{.02}$ $(Zr_{.68}Sn_{.25}Ti_{.07})_{.98}O_3$ (PZST). In addition to its use in pyroelectric conversion experiments, PZST was the subject of several basic physical studies. These studies included the electric field dependence of the electrocaloric, polarocaloric and pyroelectric effects. PZST was also studied to determine its output electrical energy density ($10mJ/cm^3K$) as a function of electric field limits, cycle temperature limits, and type of thermodynamic cycle. Furthermore, the effects of hysteretic loss (~ 10%) were quantified. Regenerative heat flow within the pyroelectric converter was also studied both experimentally and numerically. A plastic pyroelectric material with the required thermodynamic properties for pyroelectric conversion was found. The material is a copolymer of vinylidene fluoride-trifluoroethylene and has a potential cycle energy density of 10 to 35 times greater than existing PZST ceramic. This increased energy density results from the much higher dielectric strength of the copolymer.

29796 (SERI/CP—234-1577, pp 59-78) **Review of General Motors Corporation's TRES activities.** Weaver, R.D. (EPRI, Palo Alto, CA). 1981. NTIS, PC A11/MF A01.

From Thermo regenerative electrochemical systems workshop; Alexandria, VA, USA (3 Dec 1981).

A brief historical background for electrochemical research at General Motors is given, and some thermally regenerative electrochemical systems studied at General Motors are described. (WHK)

29797 (SERI/CP—234-1577, pp 79-86) **Ideal electrochemical heat engines compared with those using Li/sub (l)//LiI-KI-CsI-CsBr/sub (melt)//I_2/sub (g, soln)/.** Elliott, G.R.B. (Los Alamos Consultants, NM). 1981. NTIS, PC A11/MF A01.

From Thermo regenerative electrochemical systems workshop; Alexandria, VA, USA (3 Dec 1981).

The nature and some of the performance characteristics of Li/I_2 electrochemical cells with molten electrolytes appear to well satisfy many of the characteristics called for in hypothetical ideal electrochemical heat engines. Although these cells have not received adequate experimental study, they can be shown by limited experiments and theoretical arguments to be likely to exhibit the following characteristics: (a) the reactions at the electrodes are rapid and highly reversible; (b) the electrolyte has high conductivity and is stable against molten lithium; (c) the reaction of the electrolyte with iodine in the neighborhood of the positive electrode assists the movement of iodine through the electrode region and thereby helps to prevent concentration polarization; (d) the size of the triiodide ion formed by reaction with the electrolyte is expected to minimize diffusion, and the metallic lithium has little tendency to dissolve in the electrolyte; therefore, the self-discharge is expected to be small and controllable; (e) by moving only a pure cell reactant as a vapor without recourse to mechanical pumps, the system makes maximum use of the entropy change with minimal wastage of heat by friction and heat-capacity losses; (f) simple cells can be constructed into batteries and heat engines of simple design; (g) such designs can provide adequate paths for vapor transport; and (h) the electrochemical engines can be converted to electrical-storage systems with expected high performance through use of simple electrical switching. The engines, when developed and produced, will operate at temperatures which are suitable for bottoming, geothermal heat, and space uses. With solar energy they offer direct generation, backup generation with other heat sources, and storage for nights.

29798 (SERI/CP—234-1577, pp 149-158) **Condensed-state heat engines.** Olsen, R.B. (Power Conversion Technology, Inc., San Diego, CA). 1981. NTIS, PC A11/MF A01.

From Thermo regenerative electrochemical systems workshop; Alexandria, VA, USA (3 Dec 1981).

Four types of condensed-state heat engines, ferromagnetic, pyroelectric, thermoelastic, and liquid, and discussed. The physical phenomena which are basic to these engines are introduced. Common features of these engines are listed. In addition, the special characteristics of each device are illuminated.

29799 (SERI/CP—234-1577, pp 177-183) **System of supportive coupled electrochemical cells operating in closed-loop for the conversion of heat into electrical energy.** Rapp, R.A. (Ohio State Univ., Columbus). 1981. NTIS, PC A11/MF A01.

From Thermo regenerative electrochemical systems workshop; Alexandria, VA, USA (3 Dec 1981).

A system is conceptualized for the conversion of heat into electrical energy. Two different electrochemical cells at different tempertures are coupled both electrically and through their common use of two virtually closed loops of electrode gases. The particular cells and specific electrode gases are chosen such that the product anode gas from the high-temperature cell serves as the

reactant cathode gas (oxidant) for the low-temperature cell, where reaction virtually regenerates the reactant anode gas (fuel) for the high-temperature cell. Likewise, the product anode gas from the low-temperature cell serves as the oxidant (cathode gas) for the high-temperature cell, where reaction virtually regenerates the reactant anode gas (fuel) for the low-temperature cell. Thus, the operation of the system requires no consumption of either a fuel or an oxidant. In the specific illustrative system, these two loops of gases are closed except for the addition or removal of water vapor, a process requiring only readily available, low-quality heat. According to this mode of coupling two electrochemical cells with two closed loops of gases, the chemical cell reactions of the high-temperature and low-temperature reactions are identical, but reversed in direction. The high-temperature reaction is endothermic (by selection), so that the low-temperature reaction is necessarily exothermic. By selecting chemical cell reactions with very large entropy changes and adapting to these reactions a pair of cells at greatly different temperature, the series-coupled cells can run spontaneously. Then the net result of the operation of this system is the conversion of high-temperature heat into electrical energy.

32 ENERGY CONSERVATION, CONSUMPTION, AND UTILIZATION

REFER ALSO TO CITATION(S) 29752, 29768

29800 **(PB—83-136960) Energy future Santa Cruz. A citizens' plan for energy self-reliance.** Cohn, J.; Stayton, R. (Resource Transitions, Inc., Santa Cruz, CA (USA)). 1982. 104p. NTIS, PC A06/MF A01.

The results of a grassroots energy conservation project which involved more than 3,100 residents of Santa Cruz, California, is discussed. Citizens attended forums and town meetings to suggest ideas for solving the community's energy problems. These ideas were then evaluated by the Energy Future Advisory Board and compiled into the Energy Future Plan. The energy plan covers such topics as new residences, residential retrofit, automobile efficiency, farm efficiency, commercial greenhouses, local food production, commercial efficiency, land use planning, energy education and financing, and solar, wind, and ocean energy. An energy implementation guide and glossary are included.

29801 **(PB—83-136986) Energy future Santa Cruz. A citizens' plan for energy self-reliance--the process report: how it happened.** Cohn, J.; Stayton, R. (Resource Transitions, Inc., Santa Cruz, CA (USA)). 1982. 16p. NTIS, PC A02/MF A01.

Results are presented of a project undertaken to demonstrate that local action could meet the energy crisis in Santa Cruz, California, and to demonstrate that a community could cooperatively develop an energy plan for greater energy self-reliance. Community participation took several forms: neighborhood outreach, community education and involvement, and media and press coverage of the project. An advisory board was formed and research was undertaken to determine the feasibility of energy ideas generated in the neighborhoods and to answer questions posed by the advisory board. Selection criteria were developed for use in screening individual actions. Thirty programs with more than 120 actions were approved and a list of 16 priorities was established. Actions implemented by the Advisory Board are noted.

3201 Buildings

REFER ALSO TO CITATION(S) 29705, 29821, 29832

29802 **(AD-A—122806/3) Least life-cycle costs for insulation in Alaska.** Flanders, S.N.; Coutts, H.J. (Cold Regions Research and Engineering Lab., Hanover, NH (USA)). Oct 1982. 56p. NTIS, PC A04/MF A01.

Recommendations for economical thicknesses for building insulation result from a study of fuel and construction costs of 12 military installations in Alaska. A comparison between the insulation thickness that a building owner might choose today and what he might choose in 20 years indicates a trend for much thicker insulation in the future. An analysis of how much more expensive a building built today with the thickness that would be appropriate 20 years hence indicates only a small penalty in life-cycle costs for the additional insulation. Therefore, a minimum of R-32 walls and R-62 attics is recommended for most of Alaska.

29803 **(CONF-830226—2) Overview of national residential and small commercial energy-conservation programs.** Karnitz, M.A.; Mixon, W.R.; Ehrenshaft, A.R. (Oak Ridge National Lab., TN (USA)). 1983. Contract W-7405-ENG-26. 12p. NTIS, PC A02/MF A01. Order Number DE83009859.

From 10. WATTEC annual energy conference; Knoxville, TN, USA (25 Feb 1983).

The National Energy Conservation Policy Act of 1978 directed the Department of Energy (DOE) to establish the Residential Conservation Service (RCS) Program, which requires large gas and electric utilities to offer on-site energy audits to their residential customers. A model energy audit procedure has been developed by Oak Ridge National Laboratory (ORNL), the Solar Energy Research Institute (SERI), and the Rocky Flats Wind Energy Program as technical assistance for voluntary use by states and utilities. The Model Audit Manual contains procedures for customer interviews, building measurements, and cost and savings calculations for applicable site-specific retrofit actions chosen from the approximately 22 nationally approved options. Data forms, calculation aids, regional weather data, and a form for presenting results to the customers are also included in the manual. The Commercial and Apartment Conservation Service (CACS) Program has extended the utility audit program to small commercial and multifamily buildings. This program will encourage the adoption of energy-conserving operation and maintenance procedures and the installation of energy-conserving measures and renewable resource measures. In conjunction with the development of the audit procedures, ORNL has undertaken research to document the accuracy of the suggested methodology, to identify additional conservation actions, and to develop a technical basis for determinig optimal cost-effective choices. Descriptions of selected research projects of the RCS Program and the CACS Program are presented.

29804 **(LA-UR—83-885) Evaporative-cooling potential for office buildings.** Peterson, J.L.; Hunn, B.D. (Los Alamos National Lab., NM (USA)). 1983. Contract W-7405-ENG-36. 12p. (CONF-830520—2). NTIS, PC A02/MF A01. Order Number DE83009887.

From 2. international congress on building energy management; Ames, IA, USA (31 May 1983).

This paper presents the results of both a performance and an economic assessment of the evaporative-cooling potential for office buildings in 11 US climate zones. Evaporative-cooling systems of the direct and combined direct/indirect type that are part of the heating, ventilating and air-conditioning (HVAC) system were evaluated. Thermal-storage strategies were not considered in this study. The DOE-2 building-energy-analysis computer program was used to simulate the evaporative-cooling performance of typical single-story and multistory office buildings. Performance results are presented as energy and peak demand reductions for each type of office building in each climate zone. Economic results are summarized as investment targets and aggregate/energy cost savings.

29805 **(LBL—11739) LBL-EPB data-acquisition system: its description and construction.** Smith, B.V.; Condon, P.E. (Lawrence Berkeley Lab., CA (USA)). Oct 1980. Contract AC03-76SF00098. 35p. NTIS, PC A03/MF A01. Order Number DE83011030.

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The microprocessor-controlled data acquisition system used for analyzing energy performance of buildings is described, including: the hardware necessary to complete a basic data acquisition system and post-manufacture modifications necessary to make the system work properly; the system programs needed to use the data collection system; and several implementations of the data logging systems which provide examples of the versatility of the system. (LEW)

29806 **(LBL—14509) Design and construction of large-area heat-flow sensors for measuring building heat flows.** Klems, J.H. (Lawrence Berkeley Lab., CA (USA)). Jan 1983. Contract AC03-76SF00098. 22p. (CONF-821217—4). NTIS, PC A02/MF A01. Order Number DE83009984.

From ASHRAE/DOE conference on thermal performance of building envelopes; Las Vegas, NV, USA (5 Dec 1982).

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The problem of measuring area-averaged heat flows in room-sized spaces in the presence of solar radiation is discussed in the context of a room-sized calorimeter facility (MoWiTT). Development of a new type of heat-flow sensor suitable for making such measurements is described, and test results for moderate-sized prototypes 1 ft (0.3 m) square are reviewed. Construction of full-sized units - up to 2 ft x 4 ft (1.2 m x 0.6 m) - is described, and problems encountered during development are discussed. It is concluded that this approach represents a viable method for determining net energy balances in rooms.

29807 **(ORNL/PPA—83/3) Stirling-powered heat pumps - a worthwhile R and D project.** Olszewski, M.; West, C.D. (Oak Ridge National Lab., TN (USA)). Apr 1983. Contract W-7405-ENG-26. 49p. NTIS, PC A03/MF A01. Order Number DE83010400.

A study has been made of the technical and economic characteristics of a gas-fired Stirling engine powered heat pump to aid management in deciding whether it is an appropriate research area for Oak Ridge National Laboratory's Engineering Technology Division. The study shows that, if reasonable cost and performance goals can be met through research and development, such a system would be very attractive to consumers, with a 3-year payback in typical climates. Over the 20-year lifetime of the system, it would produce a national benefit of perhaps $75 billion, discounted to present-day values, by saving oil and gas. In reaching this conclusion, the study compared the Stirling/Rankine system with two of its likely competitors: a very high efficiency system, and an all-electric heat pump system. These competitors were chosen because they are the most efficient space conditioning systems currently on the market. The analysis also reveals the areas in which improvements brought about through research and development would bring the greatest benefits, and thus it helps to guide the planning of research programs.

29808 **(ORNL/TM—8571) Thermal envelope field measurements in an energy-efficient office and dormitory.** Christian, J.E. (Oak Ridge National Lab., TN (USA)). Apr 1983. Contract W-7405-ENG-26. 59p. NTIS, PC A04/MF A01. Order Number DE83010453.

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A 345-m^2 earth-covered structure located at Oak Ridge National Laboratory is the focus of a DOE-sponsored building envelope research project. Based on field-measured data, heating the office and dormitory building over the 1981-1982 heating season cost $1.70/$m^2$ ($0.16/$ft^2$), assuming the cost of electricity to be $0.057/kWh. The building's thermal integrity factor is 0.016 kWh/m^2 °C (2.8 Btu/ft^2 °F). A preliminary DOE-2 model estimates the monthly electric energy needs for heating to be within 5% of our field data-derived estimates. DOE-2 building simulations suggest that this earth-covered, passively solar heated office dormitory saves 30% of the space heating and 26% of the cooling costs of an energy-efficient above grade structure. A preliminary winter energy balance has been generated from data collected in February and March and provides a fractional breakdown of thermal losses and gains. Performances have been isolated for several of the energy-conserving components: the earth-covered roof, the bermed wall, and the nonvented Trombe wall. The earth-covered roof system showed an overall thermal transmittance of 0.18 W/m^2 °C (R = 31 h ft^2 °F Btu^{-1}). The thermocouple wells in the earth surrounding the building indicate that burying a wall is more energy efficient than berming. During one week in February, the Trombe wall produced a 50% greater net thermal gain to the building than an equivalent area of south-facing windows.

29809 **Absorption-heat-pump system.** Grossman, G.; Perez-Blanco, H. US Patent Application 6-388,875. 16 Jun 1983. 23p. Contract W-7405-ENG-26.

An improvement in an absorption heat pump cycle is obtained by adding adiabatic absorption and desorption steps to the absorber and desorber of the system. The adiabatic processes make it possible to obtain the highest temperature in the absorber before any heat is removed from it and the lowest temperature in the desorber before heat is added to it, allowing for efficient utilization of the thermodynamic availability of the heat supply stream. The improved system can operate with a larger difference between high and low working fluid concentrations, less circulation losses, and more efficient heat exchange than a conventional system.

29810 **Absorption heat pump system.** Grossman, G. US Patent Application 6-388,874. 16 Jun 1982. 21p. Contract W-7405-ENG-26.

The efficiency of an absorption heat pump system is improved by conducting liquid from a second stage evaporator thereof to an auxiliary heat exchanger positioned downstream of a primary heat exchanger in the desorber of the system.

29811 **Furfuryl alcohol cellular product.** Sugama, T.; Kukacka, L.E. US Patent Application 6-382,061. 26 May 1982. 10p. Contract AC02-76CH00016.

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Self-extinguishing rigid foam products are formed by polymerization of furfuryl alcohol in the presence of a lightweight, particulate, filler, zinc chloride and selected catalysts.

29812 **Device and method for measuring the coefficient of performance of a heat pump.** Brantley, V.R.; Miller, D.R. US Patent Application 6-379,418. 18 May 1982. 14p. Contract W-7405-ENG-26.

A method and instrument is provided which allows quick and accurate measurement of the coefficient of performance of an installed electrically powered heat pump including auxiliary resistane heaters. Temperature-sensitive resistors are placed in the return and supply air ducts to measure the temperature increase of the air across the refrigerant and resistive-heating elements of the system. The voltages across the resistors which are directly proportional to the respective duct tempertures are applied to the inputs of a differential amplifier so that its output voltage is proportional to the temperature difference across the unit. A voltage-to-frequency converter connected to the output of the differential amplifier converts the voltage signal to a proportional-frequency signal. A digital watt meter is used to measure the power to the unit and produces a signal having a frequency proportional to the input power. A digital logic circuit ratios the temperature difference signal and the electric power input signal in a unique manner to produce a single number which is the coefficient of performance of the unit over the test interval. The digital logic and an in-situ calibration procedure enables the instrument to make these measurements in such a way that the ratio of heat flow/power input is obtained without computations. No specialized knowledge of thermodynamics or electrons is required to operate the instrument.

29813 **New Thermal Insulation Ordinance.** Ehm, H. *Bauphysik;* **4**: No. 2, 47-49(Apr 1982). (In German).

An update of the Ordinance of August 11, 1977 is presented. Heat losses due to transmission have been reduced by 20% to 25%, keeping the cost increase to renters as low as possible. The new Ordinance is the first to cover retrofit of older buildings in which components are newly installed, replaced or reconstructed. It has been abridged and simplified but also extended in some respects.

29814 **(NP-tr—3901620) Ceramic boilers: ready for series production in 3 years.** Translated from *Sanitaer - Heizungstechnik ;* **46**: No. 4, 386-388(Apr 1981). 12p. NTIS (US Sales Only), PC A02/MF A01. Order Number DE83901620.

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The production of ceramic combustion chambers and heat exchangers for gas and oil appliances is described. Ceramic components are designed like small plate-type heat exchangers. They consist of slotted blocks, and a large number of material flows can be precisely guided in these flow slots. The blocks can be used to build complete boilers and burners. Development is proceeding rap-

idly. In the meantime, various firms in the heating sector have participated, and the Federal Ministry for Research is also providing financial support for the work. It is hoped to be able to present heating installations, ready for the market, at the end of 1983.

29815 (NP-tr—3901613) Refrigerant mixtures for sorption heat pumps. Stephan, K.; Seher, D. Translated from *Ki, Klima, Kaelte, Heizung ;* 6: No. 1, 865-876(1980). 38p. NTIS (US Sales Only), PC A03/MF A01. Order Number DE83901613.

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To be able to consider the suitability of working mixtures for sorption heat pumps, a catalogue of criteria and properties, with which the mixtures have to comply, has been prepared. Various substances which appear to be suitable for use as working medium and solvent are compared by means of this catalogue. An investigation of the literature showed that about 70 binary mixtures and several ternary mixtures are worthy of discussion. However, the thermodynamic properties of only a few of these mixtures are sufficiently well known for their suitability for the sorption heat pump to be investigated. Mixtures, whose thermodynamic properties are sufficiently known, have been investigated more closely and the advantages and disadvantages of their use in sorption heat pumps are stated.

3202 Transportation

REFER ALSO TO CITATION(S) 29860

29816 (DOE/PE/70045—1) Highway fuel-consumption model. Ninth quarterly report. (Energy and Environmental Analysis, Inc., Arlington, VA (USA)). Feb 1983. Contract AC01-78PE70045. 61p. NTIS, PC A04/MF A01. Order Number DE83010685.

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The most current output of the Highway Fuel Consumption model is reported and revisions in the input data and assumptions which have occurred in the past few months are discussed. The current projection of highway fuel consumption are presented and it is compared to the one used in the preceding report of this series. Recent activities involving the use of the model are summarized. A description of the basic model structure and methodology is presented. A copy of the February 1983 output of the model is attached.

29817 (NZERDC—80) Transport energy in New Zealand's overseas trade. A review up to 1980. Copeland, M.C.; Horsfield, A.K.; Chudleigh, P.D. (New Zealand Energy Research and Development Committee, Auckland). Oct 1982. 133p. NTIS (US Sales Only), PC A07/MF A01. Order Number DE83901604.

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Five basic options for New Zealand to reduce future transport energy requirements are listed. The background to New Zealand's trading situation is presented. Transport energy discussions are divided as follows: overseas slipping, international air freight, and internal transport. (MHR)

3203 Industry And Agriculture

REFER ALSO TO CITATION(S) 28837, 28838, 28845, 28846, 28864, 28992, 29293, 29353, 29519, 29765, 29837, 29839, 29854, 30097, 30152

29818 (AD-A—122638/0) Safety and human factors engineering analysis - heat recovery incinerator installation. Final report. (VSE Corp., Oxnard, CA (USA)). Sep 1982. 35p. NTIS, PC A03/MF A01.

This report contains a safety and human factors analysis of the Navy's heat recovery incinerator (HRI) systems. These requirements were based on current military standards and an evaluation of the HRI's at NAS, Jacksonville and NS, Mayport, Fl. The data collected were used to develop preliminary design criteria for future HRIs. The safety analysis lists specific areas where problems can occur and what should be done to prevent injury to plant personnel. The human factors design criteria section lists steps that can be taken to improve personnel and plant operating efficiency. Finally, specific problems that are occurring at NAS, Jacksonville and NS, Mayport are given.

29819 (ANL—83-9) Shellside waterflow pressure drop and distribution in industrial-size test heat exchanger. Halle, H.; Wambsganss, M.W. (Argonne National Lab., IL (USA)). Jan 1983. Contract W-31-109-ENG-38. 43p. NTIS, PC A03/MF A01. Order Number DE83010690.

The shellside pressure drop between the inlet and outlet nozzles as well as the pressure drops through individual sections of different shell-and-tube test-exchanger configurations are measured under water flow. The segmentally baffled test exchanger is nominally 0.6 m (2 ft) in diameter, 3.7 m (12 ft) long and contains a tube bundle of 19 mm (0.75 in.) outside-diameter tubes. Results are reported of 24 test cases obtained from various combinations of parameters: 30° triangular or 90° square tube layout patterns (all on a 1.25 pitch-to-diameter ratio), numbers of crosspasses, sizes of nozzles, plain or finned tubes, and full or special fix tube bundles. The exponential change of pressure drop as a function of flowrate is also investigated and an attempt is made to calculate nozzle losses.

29820 (BNL—32832) Optimal timing of investments for industrial energy conservation. Anandalingam, G. (Brookhaven National Lab., Upton, NY (USA)). 1982. Contract AC02-76CH00016. 18p. (CONF-821012—6). NTIS, PC A02/MF A01. Order Number DE83010826.

From Institute for Management Sciences/Operations Research Society of America joint meeting; San Diego, CA, USA (25 Oct 1982).

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A brief presentation is made of the present methods of analyzing investments in energy conservation and their weaknesses in the present context. Methods are proposed whereby uncertainty could be taken into account in these techniques. The deterministic and stochastic models are presented; results regarding optimal investment timing are derived; and the behavior of the decision rules are investigated. Major conclusions are reported. (MHR)

29821 (CONF-8204108—1) Using mine waters for heating and cooling. Schubert, J.P.; McDaniel, M.J. (Argonne National Lab., IL (USA)). 1982. Contract W-31-109-ENG-38. 22p. NTIS, PC A02/MF A01. Order Number DE83009586.

From 1. international mine water congress; Budapest, Hungary (19 Apr 1982).

In northeastern Pennsylvania, two heat-pump systems are now operational and another is being constructed. These systems use waters pumped from flooded underground anthracite mines to heat and cool buildings. During winter, mine water is pumped out at about 15°C, circulated through a heat-pump system, and returned at about 11.5°C to the underground mines. Energy derived from the mine waters is more than adequate to heat the buildings with no need for conventional oil or gas boiler systems. Cooling during the summer is accomplished with the mine water heat pump systems, also at a great cost savings. These systems could be used with discharges from active mines, resulting in savings to the mining companies of 25 to 60% of what is spent on conventional heating and cooling.

29822 (DOE/BP—158) Industrial electrical cogeneration potential in the Bonneville Power Administration service area. Phase 1, technical analysis. (Rocket Research Co., Redmond, WA (USA)). 29 Feb 1980. 170p. NTIS, PC A08/MF A01. Order Number DE83010535.

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The objective of the technical analysis reported was to determine the amount of technically achievable cogeneration potential available from Pacific Northwest industries, based upon the thermal process requirements of each of the industrial plants surveyed, and not accounting for economics and cost of implementation. Efforts include: determination of the plant thermal energy demand, identification of existing equipment related to cogeneration technology, assessment of company attitudes toward cogeneration implementaton,

and estimation of electrical generation capability for the industries surveyed. (LEW)

29823 **(DOE/BP—158-Ex.Summ.) Cogeneration potential in the Bonneville Power Administration service area. Phase I. Technical analysis.** (Rocket Research Co., Redmond, WA (USA)). 19 Jan 1979. 13p. NTIS, PC A02/MF A01. Order Number DE83010536.

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The overall objective of the study reported was to determine the potential electrical/process steam cogeneratjion capacity within Washington, Oregon, and Idaho. The phase summarized was to determine the plant thermal energy needs for 150 Northwest plnats, identify existing equipment with cogeneration potential, assess company attitudes toward implementing cogeneration systems, and estimate the electrical generation capacity that is potentially achievable from the industrial plants surveyed. (LEW)

29824 **(DOE/BP—159) Cogeneration potential in the Bonneville Power Administration service area. Phase III and Phase IV. Economic analysis.** (Rocket Research Co., Redmond, WA (USA)). 29 Feb 1980. 290p. NTIS, PC A13/MF A01. Order Number DE83010538.

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An economic analysis is presented of 10 selected plants studied previously. An economic analysis of 6 plants/plant clusters optimum for cogeneration, and a generic assessment of the remaining steam topping potential in the Northwest are included.

29825 **(DOE/BP—159-Exec.Summ.) Cogeneration potential in the Bonneville Power Administration service area. Phase III and Phase IV. Economic analysis. Report RRC-80-R-671.** (Rocket Research Co., Redmond, WA (USA)). 29 Feb 1980. 28p. NTIS, PC A03/MF A01. Order Number DE83010537.

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The work summarized was economic analysis of a total of 16 different plants for the cost of cogenerated electricity. Study results indicate that there is significant electrical generation potential by industry in the Northwest, and that the cost of that energy is competitive with the new source cost to the region. Each site analyzed is briefly discussed. (LEW)

29826 **(DOE/BP—160-Exec.Summ.) Study of the feasibility of cogeneration using wood waste as fuel.** (Rocket Research Co., Redmond, WA (USA)). 10 Apr 1980. 20p. NTIS, PC A02/MF A01. Order Number DE83010350.

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The objective of this study was to evaluate the feasibility of establishing a wood- and refuse-burning thermal/electrical cogeneration facility in eastern Lewis County, Washington. The types, forms, sources, costs and availability of fuels in the area were studied along with local thermal markets and regional electrical markets. Conceptual designs, including the selection and sizing of the principal pieces of equipment, were developed for both a cogeneration and condensing cycle plant. An assessment was made of the environmental and regulatory requirements applicable to the facilities. The estimated capital and operating costs of each facility were established. Energy costs and standard capital investment economic parameters for various ownership forms were determined. The results of the study clearly indicate the feasibility of establishing a 25-MW (e) generation facility in this area. The primary location recommended is in the town of Morton, Washington. The cost of producing electrical energy is lowest with the public-utility form of ownership and is estimated at 29.0 mills/kWh in 1979 dollars. The overall direct construction cost for a condensing cycle generation plant is estimated at $30,865,200 in 1979 dollars. A Phase II program plan was developed which outlines the requirements and schedule for acquisition of the facility. The Phase II detailed design and construction program is recommended.

29827 **(DOE/CS/40064—3) Report of the University of Maine at Orono Wet-Pressing Project.** Ceckler, W.H. (Maine Univ., Orono (USA)). 24 Aug 1982. Contract AC02-78CS40064. 345p. NTIS, PC A15/MF A01. Order Number DE83009342.

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By carrying out an in-depth study of the pressing behavior of one particular type of paper in the laboratory, pilot plant, and mill, a mechanistic computer model that can be used to predict mill press behavior based on laboratory compression tests on the paper was developed. As the data base was broadened by investigating other types of papermaking furnishes, it should eventually be possible to predict press behavior using only the model and generalized correlations based on these data. An important finding of this program is that direct comparisons between laboratory, pilot plant, and mill test results indicate that mill and pilot-plant press impulse is 14 to 22% as effective as laboratory press impulse. This efficiency was referred to as nip efficiency.

29828 **(DOE/R5/10313—1) Solid waste disposal and heat recovery system.** (Goodwill Industries, Inc., St. Paul, MN (USA)). 26 Mar 1983. Contract FG02-81R510313. 3p. NTIS, PC A02/MF A01. Order Number DE83009031.

The operation of an incinerator with heat recovery boiler is reported. Problems are reported, including increased power bills, ambient temperature in the incinerator room, extra water consumption, and misdirected nozzles to spray hot ash. (LEW)

29829 **(NZERDC—71) Forest-industries energy research, 1981. Final report.** (New Zealand Energy Research and Development Committee, Auckland). Oct 1982. 89p. NTIS (US Sales Only), PC A05/MF A01. Order Number DE83901425.

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This report covers work carried out during 1981. Four separate reports related to energy use in the forest industries are included in this volume as follows: a literature review carried out during the latter part of 1980; a contribution to the Processing Options Working Party Report on energy requirements for each of four possible scenarios for the future development of New Zealand timber resources and processing; an addendum to the above, being a brief assessment of the energy used in transport operations associated with each of the four scenarios; and a report on the energy requirements of various forest industry processes.

29830 **(NZERDC—79) Energy survey of the New Zealand meat exports works.** Downey, J. (Meat Industry Research Inst. of New Zealand, Hamilton). Aug 1982. 44p. NTIS (US Sales Only), PC A03/MF A01. Order Number DE83901605.

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Energy usage of New Zealand meat export works are surveyed for the 1979/80 season. The aim of the study was to compare primary (fossil fuels and electricity) energy usage in the industry for the year ending 30 September 1980 with that for the year ending 30 July 1974 (Pearson and Pilling, 1975), to analyse works energy usage for the 1979/80 season and to identify the remaining potential for and impediments to energy conservation. To enable a basis for comparison, energy consumption data have been related to meat production (dressed weight) as MJ/kg. Between 1973/74 and 1979/80 the mean electrical energy consumption for the NZ meat industry increased from 1.60 to 1.79 MG/kg, a 12% increase. This increase is attributed to: more intensive freezing, greater use of air conditioning and the widespread introduction of screw compressors to replace aging, but more efficient, piston compressors in refrigeration plants. The mean fuel energy consumption has decreased from 6.43 MJ/kg in 1973/74 to 6.30 MJ/kg in 1979/80, a 2% decrease. This slight decrease occurred despite a greater demand for heat energy, particularly to produce hot water for processing operations. The large increases in the cost of fossil fuels apparently have had some conservation effect, particularly in oil-fired works.

29831 **New concepts reduce process energy.** Humphrey, J.L. (Argonne National Laboratory, Argonne, Illinois). *Hydrocarbon Processing;* **61**: No. 7, 141-144(Jul 1982).

The results of this program are summarized in terms of the following areas of technology: energy-efficient methods of separation; alternative fuels and feedstocks; recovery of low-level heat; and advanced concepts. Although the above technologies were identified and evaluated in terms of their application specifically to chemical plants and petroleum refineries, they have the potential of conserving oil and gas across a broad spectrum of industrial processes.

29832 **Heat absorbing jacket for high intensity lamps.** Campbell, D.E. US Patent Application 6-340,919. 20 Jan 1982. 17p.

This invention relates to and has among its objects the provision of novel apparatus for absorbing heat and infrared radiation emitted by high intensity lamps.

29833 **Waste heat from industry for district heating.** Luxembourg; Commission of the European Communities (1982). 79p. (EUR—8116-DE-EN-FR). European Communities Information Service, 2100 M Street NW, Suite 707, Washington, DC 20037.

The aim of this study is to determine the waste heat potentially recoverable from the oil-refining industry, the chemical industry, and the steel industry in order to supply district-heating networks throughout the European Economic Community. For each industrial location considered, the amount of heat potentially recoverable has been assessed in relation to the processing or production capacities of the unit in question. For each of these potential sources of industrial waste heat a maximum network length (referred to as the economic distance) has been evaluated using a simplified technical-economic model. The economic criterion used is the payback period, the upper limit selected being seven years. Within the area thus defined around the industrial location, central-ized-heating requirements have been analyzed either on the basis of the installed power of collective boilerhouses or on the basis of population density. The most-promising examples concern urban areas which already have a heat-distribution network. In the industries considered, at least 2.4 million toe could be saved in this way by making use of waste heat in order to heat over 1.7 million dwellings. It should be noted that combining several heat sources generally has a favorable effect where the projects are concerned. In addition to the heat potential estimated in this study, there could also be other potential sources of heat in other industrial activities which have not been considered. Incorporating recoverable industrial waste heat with all the other local energy sources available thus gives rise to a flexible energy-supply system better able to cope with cyclical variations in costs. Local and national political support is needed in order to get these projects off the ground and see them through.

29834 **Preliminary evaluation of large-capacity, high-lift heat pump concepts.** Bass, R.T.; Landerman, A.M. (United Technol Corp, USA). pp 29-34 of Advances in energy utilities technology. Atlanta, GA; Fairmont Press Inc. (1981).

From 4. world engineering congress; Atlanta, GA, USA (12 Oct 1981).

An analytical study was undertaken to identify heat pump system characteristics best suited for recovering low-temperature waste heat from various sources and providing it at temperature levels to match industrial needs. Six distinct waste heat sources and industrial end-uses were identified as representative applications and used for system specifications. Two applications typify large sources of waste heat and co-located industrial park end-uses while the remaining represent inplant industrial sources and end-uses. Rankine cycle heat pump configurations and working fluid options were assessed and four configurations were selected for further study on the basis of cost and performance. Five different prime movers were examined as potential compressor drivers and gas turbines and diesels were selected on the basis of high overall performance. A brief description is given of an economically attractive system for use at an industrial park near the gaseous diffusion plant at Portsmouth, Ohio. Finally, design considerations for the other applications are discussed.

29835 **Process models for industry.** Hill, D.; Howe, S.O.; Pierce, B.L. (Brookhaven Natl Lab, Upton, NY, USA). pp 259-264 of Advances in energy utilities technology. Atlanta, GA; Fairmont Press Inc. (1981).

From 4. world engineering congress; Atlanta, GA, USA (12 Oct 1981).

Mathematical programming models developed at the Brookhaven National Laboratory are used to analyzed industrial energy use in the U.S. A model of the U.S. pulp and paper industry is described and discussed as a specific application of process modeling methodology. Case study results from the pulp and paper model illustrate how process models can be used to analyze a variety of issues. Applications discussed include projections of energy demand, conservation technology assessment, energy-related tax policies, and sensitivity analysis. 8 refs.

3206 Municipalities And Community Systems

REFER ALSO TO CITATION(S) 28821, 29759, 29767, 29824, 29833

29836 **(AD-A—123170/3) Energy conservation at the West Dover, Vermont, Water Pollution Control facility. Special report.** Martel, C.J.; Sargent, B.C.; Bronson, W. (Cold Regions Research and Engineering Lab., Hanover, NH (USA)). Nov 1982. 21p. NTIS, PC A02/MF A01.

An energy audit was conducted at the West Dover, Vermont, water pollution control facility. The audit revealed that aeration, not pumping to the land treatment site, was the largest energy consumer. As a result of the audit, five Energy Conservation Opportunities (EOC) were evaluated. Three of the ECOs were recommended for implementation; these could result in annual savings of more than $6000. The remaining two ECOs were not recommended because of a large capital investment and a long payback period.

29837 **(CONF-810757—3) Potential impact of consumer choice on cogenerator's short-run price and output decisions.** Poyer, D.A. (Argonne National Lab., IL (USA)). 1981. Contract W-31-109-ENG-38. 21p. NTIS, PC A02/MF A01. Order Number DE83009039.

From 56. annual conference of the Western Economic Association; San Francisco, CA, USA (3 Jul 1981).

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Conditions were derived under which optimal price-output combinations can be determined for a profit-maximizing cogenerator faced with a demand constraint for useful energy. Four cases were considered. In two cases, all energy produced was sold to the end-use market and, in the other two, some electricity was sold to the grid. The effects of price regulation on energy output were also covered. In the short-run, in all four cases, whether or not the necessary conditions for Pareto optimality are satisfied is problematic. If the cogenerator monopolizes alternative supplies of energy, price regulation will not necessarily reduce energy expenditures. The short-term effects of constrained energy demand can only be determined with a knowledge of the cost and demand functions of thermal energy and electricity.

29838 **(CONF-820723—3) Sewage sludge disinfection by ^{137}Cs irradiation.** Fradkin, L. (Argonne National Lab., IL (USA)). 1982. Contract W-31-109-ENG-38. 7p. NTIS, PC A02/MF A01. Order Number DE83009006.

From National conference on environmental engineering; Minneapolis, MN, USA (14 Jul 1982).

The irradiator facility characterization, security aspects of process irradiators, pathogen reduction, sewage as livestock feed, and future supply and price of ^{137}Cs are discussed. (MHR)

29839 **(CONF-8204123—1) Resource conservation through beverage-container recycling.** Gaines, L.L.; Wolsky, A.M. (Argonne National Lab., IL (USA)). 1982. Contract W-31-109-ENG-38. 20p. NTIS, PC A02/MF A01. Order Number DE83009562.

From 4. world recycling congress; New Orleans, LA, USA (5 Apr 1982).

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Since the introduction of plastic soft-drink bottles in 1977, the 2 liter container has captured almost the entire US market. The number of PET (polyethylene terephthalate, a polyester) bottles used in 1981 was 2.4 billion, and could grow to 14 billion by 1990 if the penetration into the 1/2 liter market is as rapid as some experts predict. Consumers value the PET bottle's light weight and unbreakability. However, plastic bottles are made from oil and gas feedstocks which are imported and becoming more expensive. Recycling drastically reduces the oil and gas required to supply these bottles; recycling PET from bottles to other uses could save on the order of 6 million barrels of oil equivalent per year by 1990. A simple and economic technology is available for performing this recovery yet only 5% of the bottles used in 1980 were returned. What is missing is an effective inducement for bottle return. The reverse-vending machines that are proposed can provide part of that inducement by eliminating the inconvenience that now surrounds the sale of empty bottles to recyclers. These machines would dispense coins in return for empty PET bottles, and these machines could be located in supermarkets or their parking lots. It is believed that the design, construction, and use of such machines is an opportunity that has been overlooked.

29840 **(DOE/CS/20038—2) A.S.E.F. solid waste to methane gas, Pompano Beach, Florida. RefCOM: technical status report, February 1 to April 2, 1983.** (Waste Management, Inc., Oak Brook, IL (USA)). Apr 1983. Contract AC02-76CS20038. 42p. NTIS, PC A03/MF A01. Order Number DE83009448.

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This report contains data from runs in February and March 1983 at the RefCOM facility. Such data as number of hours run in relation to number of tons of materials fed into the digestor; relation between tons fed and subsequent gas production; relation between methane and carbon dioxide in the off gas; effluent environment; effluent nutrient values; raw material analysis; and filter cake analysis are presented. (MHR)

29841 **(DOE/CS/20070—T1-Exec.Summ.) District-heating-and-cooling system for communities through power-plant retrofit and distribution network. Phase 2. Final report.** (Detroit Edison Co., MI (USA); Detroit, City of, MI (USA); Smith-Hinchman and Grylls Associates, Inc., Detroit, MI (USA); EKONO, Inc., Bellevue, WA (USA)). Feb 1983. Contract AC02-78CS20070. 17p. NTIS, PC A02/MF A01. Order Number DE83009305.

This Phase 2 report centers on Detroit Edison's Conners Creek power plant and refinements in the analysis of a combined steam and hot water district heating system supplied from that plant. Because of the changes in the economic climate in the Detroit area and the closing of a number of businesses, the Phase 2 analysis could not be carried on directly from the results of Phase 1.

29842 **(DOE/CS/20070—T1-Vol.1) District-heating-and-cooling system for communities through power-plant retrofit and distribution network. Phase 2. Final report.** (Detroit Edison Co., MI (USA); Detroit, City of, MI (USA); Smith-Hinchman and Grylls Associates, Inc., Detroit, MI (USA); EKONO, Inc., Bellevue, WA (USA)). Feb 1983. Contract AC02-78CS20070. 191p. NTIS, PC A09/MF A01. Order Number DE83009306.

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This report represents the completion of the second phase of the district heating and cooling project in Detroit. Although it was based upon the analysis and conclusions of the first phase, a number of changes in Detroit's economy and the future of several key potential users caused some divergence from the original Phase II proposal. The intent at the beginning of Phase II was to develop a new district heating system based upon the Conners Creek power plant and to interconnect this system with the existing district heating system as the beginning of a city-wide district heating system. The main component of the interconnection was to be a new plant located approximately midway between the Conners Creek plant and the existing system. In addition to serving the two district heating systems, this plant was to supply process steam to two industrial plants. Shortly after Phase II began, both of the industrial plants were closed. This removed the primary support for the new district heating plant and caused the analysis of the Conners Creek system to be independent of the existing district heating system.

29843 **(DOE/CS/20070—T1-Vol.2-App.) District-heating-and-cooling system for communities through power-plant retrofit and distribution network. Phase 2.** (Detroit Edison Co., MI (USA); Detroit, City of, MI (USA); Smith-Hinchman and Grylls Associates, Inc., Detroit, MI (USA); EKONO, Inc., Bellevue, WA (USA)). Feb 1983. Contract AC02-78CS20070. 136p. NTIS, PC A07/MF A01. Order Number DE83009307.

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Appendices are presented containing data, exhibits, flowsheets, etc. for the following tasks: marketing, plant retrofit, distribution system, and economic analysis. (MHR)

29844 **(DOE/CS/24360—1) Minnesota State plan to implement district heating. Executive summary.** (Minnesota Dept. of Energy, Planning and Development, St. Paul (USA)). 15 Mar 1983. Contract AC02-80CS24360. 10p. NTIS, PC A02/MF A01. Order Number DE83010633.

Three mechanisms to help communities reduce their risk in implementing district heating systems are described briefly: a District Heating Planning Guidebook, a $300,000 grant program for preliminary planning, and a $50 million loan program for design and construction. (MHR)

29845 **(DOE/CS/24360—T1) District-heating planning in Minnesota: a community guidebook.** (Minnesota Energy Agency, St. Paul (USA)). 1982. Contract AC02-80CS24360. 130p. NTIS, PC A07/MF A01. Order Number DE83009528.

Major activities involved in a local district heating project are highlighted. Independent assessment is the first step communities take in the process, and a questionnaire is provided to help evaluate local conditions for district heating. A step-by-step method is given for estimating the capital investment costs for a district heating system for a specific community. The procedures enable a community to make an early assessment of the economics of their proposed system and begin a detailed investigation and determination of the characteristics of each development component. Information is given on how to plan and design a district heating system and how a community acquires the engineering, economic, and financial expertise required for this and subsequent phases. Special considerations are outlined for final design, construction, and operation of the system. Various system ownership options available to communities are reviewed in detail. Primary criteria are described for selecting the most suitable alternative as well as additional considerations regarding the options for the separate system components. Various funding sources for district heating development are summarized. (LEW)

29846 **(DOE/CS/24360—T2) Minnesota State Plan to implement district heating. Final report.** (Minnesota Dept. of Energy, Planning and Development, St. Paul (USA)). 15 Mar 1983. Contract AC02-80CS24360. 54p. NTIS, PC A04/MF A01. Order Number DE83010302.

The plan to implement district heating in Minnesota is described, including: technical research and assistance, public involvement, legislative initiatives, marketing, and financing. (LEW)

29847 **(DOE/CS/40337—14-Vol.2) Urban integrated industrial cogeneration systems analysis. Phase I, final report. Volume 2. Selecting and evaluating sites for integrated industrial cogeneration systems in the City of Chicago.** (Chicago Dept. of Planning, IL (USA)). Mar 1982. Contract FG02-80CS40337. 80p. NTIS, PC A05/MF A01. Order Number DE83009705.

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A methodology developed for identifying and evaluating cogeneration opportunities in urban industrial areas is described. The evaluation and results focus on the Chicago area specifically. (MHR)

29848 **(DOE/CS/40337—14-Vol.5) Urban integrated industrial cogeneration systems analysis. Phase I, final report. Volume 5. Technology assessment of cogeneration and alternative fuels in Chicago.** Porter, R.W. (Illinois Inst. of Tech., Chicago (USA). Dept. of Mechanical Engineering). Dec 1982. Contract FG02-80CS40337. 59p. NTIS, PC A04/MF A01. Order Number DE83010330.

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Discussion of introductory aspects, thermal performance of selected equipment, economic analysis, and a summary of results of (appended) feasibility case studies are included. The technical and economic data are appended, as is a journal article published on the general thermal-economic analysis. While based on simplified performance, cost and user data, the article can be considered to document the basic approach of the study. Also appended is a bibliography of selected technical memoranda generated in support of the project and referenced herein. Also appended are the abstracts of three more comprehensive technical reports on the subject matter which will also be available from IIT or National Technical Information Service (NTIS).

29849 **(DOE/CS/40337—14-Vol.6) Urban integrated industrial cogeneration systems analysis. Phase I, final report. Volume 6. Industrial cogeneration potential in Chicago, 1980 to 2000.** Marciniak, T.J. (Fauske and Associates, Inc., Burr Ridge, IL (USA)). Dec 1982. Contract FG02-80CS40337. 82p. NTIS, PC A05/MF A01. Order Number DE83010332.

A general overview of Chicago's industrial present and future is given. This analysis is important for two reasons. An analysis of the likely technical market for cogeneration in Chicago is presented. These are the industrial sites which have the necessary technical attributes to make them attractive candidates for further consideration for cogeneration facilities. An estimate of the economic parameters which will either make or break economic decisions to install cogeneration equipment is included. Further, an estimate is made of the potential economic market for cogeneration facilities between now and the year 2000. A wrap-up of the main conclusions of the study is given along with some recommendations for further action which may help establish industrial cogeneration as a viable energy conservation strategy in Chicago. Of 12,000 firms, only 280 were found to have a strong technical potential for a cogeneration application. Further analysis indicated that the actual technical market involved 88 plant sites with a total capacity of 983 MW. The economic market was found to be limited using 1981 energy prices. Twenty-eight sites having a total capacity of 150 MW/sub e/ were found to have positive ROI's, and of these 5 had ROI's greater than 10 percent. The most important factor affecting economic viability was the differential price between purchased electricity and fuel. A real inflation rate of 2.0 percent for electricity increased the market to 53 sites with a capacity of 944 MW/sub e/, with 10 having ROI's greater than 10 percent.

29850 **(DOE/RA/50302—1) Preliminary engineering report for Fort Smith refuse-derived energy project.** (Fort Smith, City of, AR (USA); Hodges, Vines, Fox and Associates, Little Rock, AR (USA)). Mar 1983. Contract FG01-80RA50302. 145p. NTIS, PC A07/MF A01. Order Number DE83010179.

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Recommendations for two sites are presented. The following topics are discussed: project development options, energy and revenue assessments, cost projections and financing costs, revenue projections and economic assessment, plant ownership and operation, city administration, and economic feasibilities. (MHR)

29851 **(DOE/RA/50366—1) Utilization of landfill gas for a vehicle fuel system: Rossman's Landfill, Clackamas County, Oregon. Feasibility study.** (EMCON Associates, San Jose, CA (USA); Cal Recovery Systems, Inc., Richmond, CA (USA); Gas Recovery Systems, Inc., Pasadena, CA (USA)). Feb 1983. Contract FG01-80RA50366. 221p. NTIS, PC A10/MF A01. Order Number DE83010622.

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The areas addressed in this feasibility study include: landfill gas yield and collection, including an estimate of production rates, a prediction of methane yield versus time, and development of a conceptual gas-gathering system; gas processing, compressing, and storage, including a review of current state-of-the-art and relevant case histories, development of alternative processing options, selection of an optimum system, and conceptual design; and methane-fueled vehicle systems, involving review of the state-of-the-art and evaluation of case histories, development of alternative fuel systems, and final selection of the optimum system. Cost estimates are included as an integral part of each area of study. Presented also is a summary of total project costs and economic feasibility.

29852 **(DOE/RA/50367—1) Feasibility of methane-gas recovery at the St. John's Landfill.** (Metropolitan Service District, Portland, OR (USA); Gas Recovery Systems, Inc., San Mateo, CA (USA)). Mar 1983. Contract FG01-80RA50367. 259p. NTIS, PC A12/MF A01. Order Number DE83010623.

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All facets reviewed in assessing the feasibility of a commercial landfill gas recovery system at the St. Johns Landfill in Portland, Oregon are discussed. Included are: landfill operational history, step-by-step descriptions of the field testing (and all results therein), landfill gas production/recovery predictions, results of the preliminary market research, cost matrices for primary utilization modes, and conclusions and recommendations based on analysis of the data gathered. Tables and figures are used to illustrate various aspects of the report.

29853 **(ECE/COAL—68) Use of coal for urban district heating.** (United Nations, New York (USA)). 18 Oct 1982. 20p. United Nations, New York, NY.

The use of coal for urban district heating is examined in Belgium, Finland, Poland, Sweden, Czechoslovakia and France. Italy does not use coal for this purpose. The demand for energy for space and tap water heating is discussed, district heating plants are described and their performances studied. Future plans of the countries are outlined.

29854 **(OTA-E—192) Industrial and commercial cogeneration.** (Office of Technology Assessment (U.S. Congress), Washington, DC). Feb 1983. 302p. GPO.

The central issues surrounding cogeneration are highlighted and OTA's findings on those issues are summarized. The context in which cogenerators will operate is reviewed, including the national energy situation, current electric utility operation, and the regulation and financing of cogeneration systems. An overview of the cogeneration technologies is presented, including their operating and fuel use characteristics, projected costs, and requirements for interconnection with the utility grid. The opportunities for cogeneration in industry, commercial buildings, and rural areas are analyzed. The impacts of cogeneration on electric utilities' planning and operation and on the environment, as well as on general economic and institutional factors such as capital requirements, employment, and the decentralization of energy supply are assessed. Policy considerations for the use of cogeneration technologies are discussed. The appendices include a description of the model used to analyze commercial cogeneration and of the methods used to calculate emissions balances for air quality analysis, as well as a glossary of terms and a list of abbreviations used. (MHR)

29855 **(PNL—4470) Avoided cost standard under PURPA.** Cole, R.J.; Holmlund, I.; Smith, S.A.; Williams, T.A. (Pacific Northwest Lab., Richland, WA (USA)). Apr 1983. Contract AC06-76RL01830. 22p. NTIS, PC A02/MF A01. Order Number DE83010985.

The Public Utility Regulatory Policies Act (PURPA) (P.L. 95-617) was passed to encourage electricity conservation through a variety of regulatory and rate reforms. Information is provided on the controversy surrounding the avoided cost standard established under PURPA. Promulgated by the Federal Energy Regulatory Committee (FERC) in February 1980, the avoided cost standard sets a minimum rate for utilities purchasing power from a qualified facility (QF) at the utilities full avoided cost. Recent court cases have challenged this standard and FERC is currently appealing to

the Supreme Court. The impact of these court cases may have little effect on the actual rates set by state Public Utility Commissions (PUCs), which can require rates higher than the minimums established by FERC, since many PUCs appear in favor of requiring full avoided costs. The arguments for and against requiring utilities to pay full avoided costs come down to balancing between incentives for QFs on the one hand and fairness to utilities and their non-QF customers on the other.

29856 **Megawatts from municipal waste.** Lihach, N. *EPRI (Electric Power Research Institute) Journal;* 8: No. 1, 20-25(Jan-Feb 1983).

Technical and institutional difficulties have hampered some efforts to co-fire municipal solid wastes (MSW) in utility coal- or oil-fired boilers, but there is a new trend for communities to burn MSW or refuse-derived fuels (RDF) in dedicated boilers and sell the steam or electricity to the utilities. Four MSW technologies involve RDF co-firing, dedicated RDF facilities, dedicated MSW facilities, and landfill gas recovery. Technical problems with co-firing that jeopardized utility efficiency, reliability, and availability found workable solutions, but institutional problems in the form of low financial incentives due to regulations against utility profits continued until communities found a mutual solution in community-owned dedicated refuse-burning plants. 7 references, 2 figures. (DCK)

33 ADVANCED AUTOMOTIVE PROPULSION SYSTEMS

3301 Internal Combustion Engines

REFER ALSO TO CITATION(S) 30095

29857 **(DOE/ER/10163—T1) Reduction in fuel consumption in internal combustion engines. Final report.** Grant, J.F.; Golenko, Z.; McIlwain, M.E.; Marram, E.P. (Geo-Centers, Inc., Newton Upper Falls, MA (USA)). Aug 1982. Contract AC01-80ER10163. 181p. (GC-TR—82-168). NTIS, PC A09/MF A01. Order Number DE83006947.

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This program approached automotive fuel consumption from two directions: (1) to model the automobile using mathematical formulations, and (2) to investigate the ignition of lean fuel/air mixtures using plasma jet ignition. The mathematical model was used to predict the impacts that various changes in the properties of the vehicle such as engine compression ratio, engine displacement, and body weight would have on the driving performance and fuel economy of the vehicle. Plasma jet ignition was identified as a potential means of allowing non-lean burn engine designs to retain their performance when operated on lean fuel/air mixtures. Plasma jet ignition was investigated in quiescent and turbulent mixtures in a constant volume combustion chamber to identify those properties of the plasma jet which resulted in efficient combustion of lean fuel/air mixtures. These improved properties were incorporated into engine compatible prototype plugs. The single-cylinder engine performance was evaluated using these prototype plugs.

29858 **Regenerative gas turbine with thermal-energy conservation.** Best, G.C. US Patent Application 6-389,343. 17 Jun 1982. 10p.

A thermal-energy conservation system for a regenerative gas turbine, and preferably a highly-regenerated high-temperature two-shaft gas-turbine engine, operating at an equilibrium temperature is provided. The gas-turbine engine includes a compressor, a combustor, a fuel throttle, a turbine, and a regenerator which transfers thermal energy from the heated exhaust gases of the turbine to the compressed air delivered to the combustor. A compressor air-inlet throttle is operatively associated with the fuel throttle so that the flow of air to the compressor is reduced to a predetermined level when the fuel throttle is moved from a high power position to a low power or negative power position. This reduced air flow to the compressor causes a corresponding reduced flow of gases to the turbine and results in engine braking. With the heat added by engine braking, the thermal energy of the gas-turbine engine and particularly of the regenerator is substantially maintained and conserved at the equilibrium temperature with minimum cooling. In a preferred embodiment, the compressor air-inlet throttle is constituted by the guide vanes of the compressor.

29859 **Enhanced ignition for I.C. engines with premixed gases.** Dale, J.D. (Univ. of Alberta, Edmonton); Oppenheim, A.K. *SAE (Society of Automotive Engineers) Journal;* 1-16(1981). Contract W-7405-ENG-48.

From International Congress and Exposition; Detroit, MI, USA (23 Feb 1981).

The development of lean charge, fast burn engines depends crucially on enhanced ignition. Enhanced ignition involves not only high energies and long duration of ignition, but also a wide dispersion of its sources, so that combustion is carried out at as many sites throughout the charge as possible. Upon this premise, various ignition systems for I.C. engines, operating with premixed charge, are reviewed. The systems are grouped as follows: high energy spark plugs; plasma jet igniters; photochemical, laser, and microwave ignition concepts; torch cells; divided chamber stratified charge engines; flame jet igniters; combustion jet ignition concepts; EGR ignition system. The first three derive the power from electrical energy, the rest are powered by exothermic chemical reactions. The review emphasizes the concept of staging the processes of initiation and propagation of combustion. Relative positions of various ignition systems are expressed on the plane of relative energies (the ratio of energy consumed by the ignition system, or contained in a pre-chamber, to that of the compressed charge in the main chamber) and relative volumes (the ratio of the volume of the pre-chamber to that of the compressed charge). In principle, ignition systems for engines operating with premixed charge lie on the half-plane of relative energies below one, between 10^{-6} for standard spark plugs to 10^{-1} for divided chamber stratified charge engines, while their relative volumes extend from 0 for spark igniters to 0.2 for stratified charge engines. This suggests that proper compartmentization of the combustion process may lead to significant improvements in both pollution emissions from the cylinder and specific fuel consumption of I.C. engines.

3302 External Combustion Engines

29860 **(CONF-8204126—1) Advanced locomotive heat engines.** Daley, J.G.; Kirsch, L.W. (Argonne National Lab., IL (USA)). 1982. Contract W-31-109-ENG-38. 28p. NTIS, PC A03/MF A01. Order Number DE83010695.

From ASME/IEEE joint spring conference; Erie, PA, USA (19 Apr 1982).

Continued high cost and potential future limitations on the supply of diesel fuel are leading to reexaminations of the two established options to diesel power: coal-burning steam engines and electrification. Electrification would provide a long-term solution but requires a massive commitment of capital and the resolution of many political and legal problems. The alternative of using heat engines that utilize less-expensive fuels (especially coal) would not entail a huge initial investment but creates many operational problems in supplying, handling, storing and using another type of fuel; compatibility of new locomotives with existing units; and maintaining the new units with acceptable reliability. Fuel efficiency is considered to be important since it directly affects cost, fuel-storage requirements and, in the case of coal, ash-disposal requirements. The class of heat engines that possess the greatest degree of fuel flexibility and could be used in railroad service with either a wide spectrum of liquid fuels or with solid coal are known as external-combustion engines. The reciprocating steam engine and steam turbines are the most-familiar engines in this class which also includes external combustion Brayton cycle engines (gas turbines) and Stirling engines. This paper examines the economic, technical, and operational issues involved with use of external-combustion engines in modern railroad service. Development of suitable combustor and heat-exchange equipment is a critical problem area and, while a modern version of the reciprocating steam engine could be made available erliest, advanced engines such as a closed-cycle version of the external-combustion Brayton appear to have the best long-term promise but require a significant development effort.

3303 Electric-powered Systems

REFER ALSO TO CITATION(S) 29708

29861 **(CONF-830201—3) Design considerations for a Li-Al/FeS battery for an electric van.** Chilenskas, A.A.; Shimotake, H.; Barney, D.L.; Sasaki, T.; Kimura, Y.; Goto, K.; Toda, T. (Argonne National Lab., IL (USA); Toyota Motor Co. Ltd., Aichi (Japan)). 1983. Contract W-31-109-ENG-38. 5p. NTIS, PC A02/MF A01. Order Number DE83009504.

From Society of Automotive Engineers congress; Detroit, MI, USA (28 Feb 1983).

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A study on battery-vehicle design interactions was performed jointly by Argonne National Laboratory and Toyota Motor Company. A Toyota Hi-Ace van converted to electric drive was used to model the performance of the vehicle. Power train requirements were calculated on the basis of achieving performance equivalent to that of gasoline-engine or diesel-powered vehicles. Vehicle energy requirements were obtained by integrating the power required to complete a SAE J227a/D cycle. A weight analysis for the conversion was completed as well as a preliminary design to locate the batteries within the vehicle without encroaching upon passenger space. The power/energy ratio of the battery was determined as a function of the vehicle range. Specifications for the vehicle and battery for several cases of interest (e.g., gasoline or diesel type acceleration) are given.

29862 **(DOE/CS/50110—1) Engineering field test of electric vehicles. Final report.** Ogborn, L.L.; McDonald, A.T. (Purdue Univ., Lafayette, IN (USA). Inst. for Interdisciplinary Engineering Studies). Dec 1982. Contract AC02-80CS50110. 135p. NTIS, PC A07/MF A01. Order Number DE83009539.

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This report documents the development of a digital data acquisition system (DAS) for use in electric vehicle (EV) research, development, and engineering field test programs. The system was designed for use in mission activities, as well as for accumulating baseline vehicle performance data. The system architecture, hardware components, and modular software design are described. Sensor choices, system installation, calibration, and operation are also treated. Methods of handling and processing of EV data are discussed. Discussion of problems encountered and precautions required for satisfactory operation should be useful in future programs. Complete hardware and software documentation is included.

29863 **Comparison between features and performance characteristics of fifteen hp samarium cobalt and ferrite based brushless dc motors operated by same power conditioner.** Demerdash, N.A.; Miller, R.H.; Nehl, T.W.; Overton, B.P.; Ford, C.J. (Va Polytech Inst & State Univ, Blacksburg, USA). pp 9p, Paper 82WM 241-8 of IEEE Power Engineering Society winter meeting. New York, NY; IEEE (1982).

From IEEE Power Engineering Society winter meeting; New York, NY, USA (30 Jan 1982).

The impact of samarium-cobalt and ferrite magnet materials on the design and performance characteristics of electronically commutated brushless dc motors of equal horsepower output is presented. This is accomplised through the design, construction and testing of two 15 hp, 120 volt brushless dc motors built for propulsion of electric vehicles, and similar applications. In one of these motors, samarium-cobalt (Sm Co/sub 5/) is used as permanent magnet material, while in the other the magnets were made of strontium ferrite number 8. The two machines were built to operate from the same power conditioner, which consisted of a transistor chopper in series with a three phase full wave inverter/converter bridge, which consists of six transistor-diode switches. Both motors achieved a continuous 2 hour rating of more than 15 hp with a peak one minute rating of 35 hp. System efficiency (combined motor and conditioner) under rated conditions of 90% was achieved for both machines. Details of these and other performance and analyzed to assess the impact of choice of magnet material on design and performance for this, as well as other applications. 7 refs.

3308 Alternative Fuels

REFER ALSO TO CITATION(S) 29767

36 MATERIALS

3601 Metals And Alloys

REFER ALSO TO CITATION(S) 28863, 28912, 28952, 28953, 28954, 28955, 28957, 29156, 29369, 29389, 29393, 29396, 29541, 29548, 29553, 29557, 29557, 29561, 29567, 29567, 29568, 29571, 29698, 29698, 29723, 29725, 29795, 30024, 30319

29864 **(BNL—32796) Dissolution and passivation kinetics of Fe-Cr-Ni alloys during localized corrosion.** Newman, R.C.; Isaacs, H.S. (Brookhaven National Lab., Upton, NY (USA)). 1983. Contract AC02-76CH00016. 7p. (CONF-830534—1). NTIS, PC A02/MF A01. Order Number DE83010430.

From 5. international symposium on passivity; Bombannes, France (30 May 1983).

An artifical pit technique has been used to study the anodic and cathodic behavior of Fe-Cr-Ni alloys during localized corrosion in neutral chloride solutions. The active dissolution kinetics have been determined as a function of the concentration of the localized environment, and the conditions for passivation established. Platinum microelectrodes have been used to analyze the pit solutions. The cathodic behavior of a pit on type 304L stainless steel is dominated by copper ions dissolved in the pit. A high purity Fe-Cr-Ni alloy behaves like stainless steel if copper is separately dissolved in the pit environment. The variation of dissolution rate with concentration of corrosion products is used to show that localized corrosion can involve as many as five diffusion-coupled steady states. The stability of these states is discussed. 6 figures.

29865 **(CONF-810913—Vol.2) Environmental degradation of engineering materials in hydrogen.** Louthan, M.R. Jr.; McNitt, R.P.; Sisson, R.D. Jr. (eds.). (Virginia Polytechnic Inst. and State Univ., Blacksburg (USA). Lab. for the Study of Environmental Degradation of Engineering Materials). 1981. 496p. Virginia Polytechnic Institute, Laboratory for the Study of Environmental Degradation of Engineering Materials, 201 Holden Hall, Blacksburg, VA 24061.

From International conference on environmental degradation of engineering materials; Blacksburg, VA, USA (21 Sep 1981).

This book is one volume of the proceedings of the second conference on Environmental Degradation of Engineering Materials held at Virginia Polytechnic Institute on September 21-23, 1981. Papers in this volume describe hydrogen uptake and transport by metals, hydrogen adsorption and evolution from metals and hydrogen embrittlement of metals. These papers represent about one third of the presentations at the conference and reflect the importance currently attached to the development of an understanding of hydrogen embrittlement processes. Thirty-nine papers have been abstracted and indexed for the Energy Data Base.

29866 (CONF-810913—Vol.2, pp 3-10) **Relation of hydrogen effects on plasticity to the cracking of steels.** Oriani, R.A. (Univ. of Minnesota, Minneapolis). 1981. Virginia Polytechnic Institute, Laboratory for the Study of Environmental Degradation of Engineering Materials, 201 Holden Hall, Blacksburg, VA 24061. Contract AC02-79ER10450.

From International conference on environmental degradation of engineering materials; Blacksburg, VA, USA (21 Sep 1981).

The relatively small amount of data on the effects of low-fugacity hydrogen on iron and steels is examined for relevance to cracking models. It is concluded that the concept that hydrogen embrittlement of steels arises from an enhancement of localized slip at crack tips is not supported by the data, and that more carefully contrived experiments are needed to elucidate the role of plastic deformation in crack propagation.

29867 (CONF-810913—Vol.2, pp 13-42) **Concerning adsorbed and absorbed hydrogen on and in ferrous metals.** Flitt, H.J. (Finders Univ., of South Australia, Bedford Park); Bockris, J.O'M. 1981. Virginia Polytechnic Institute, Laboratory for the Study of Environmental Degradation of Engineering Materials, 201 Holden Hall, Blacksburg, VA 24061.

From International conference on environmental degradation of engineering materials; Blacksburg, VA, USA (21 Sep 1981).

Fe specimens containing 0.2% carbon were chosen to minimize D/sub H/ and maximize c/sub H/, 0.4 M H_2SO_4 solutions were used. Additives were napthanitrile, napthalene, benzonitrile, H_2S, $Na_2H_2PO_4$. The following measurements were made: (1) Steady state hydrogen evolution as a function of potential in the absence and presence of additives; (2) constant current transients with the initial potential in the hydrogen evolution region and a region positive to the corrosion potential; (3) laser desorption of hydrogen - a Neodynium-Yag laser was used to introduce micro-cavities into the metal after its exposure to hydrogen from solution at various fugacities. The H was measured in a quadrupole mass spectrometer, and analyses of the pH/time transient yields the H concentration (c/sub H/) in the region of metal struck by the laser. Among the experimental findings are: (1) All the additives, independent of their effect upon corrosion, decrease the exchange current density. (2) Nitriles and Phosphates increase the Tafel slopes, while sulfide and napthaline reduce them. (3) Nitriles and phosphates increase the d eta d ln θ slopes, but sulfide and napthaline decrease them. (4) Phosphate and benzonitrile reduce the value of θ to the greatest extent. There is no consistent reduction due to napthaline and hydrogen sulfide. (5) The order of magnitude of the hydrogen surface coverage during its change with potential is 1 to 10%, referring to the whole surface. (6) All additives increase the content of internal hydrogen. There is a parabolic relation of the equilibrium constant with overpotential. (7) Theta/sub eta/ is lowered by all additives.

29868 (CONF-810913—Vol.2, pp 55-67) **Hydrogen behavior in coated and uncoated low alloy steels.** Kargol, J.A.; Fiore, N.F.; Paul, L.D. (Univ. of Notre Dame, IN). 1981. Virginia Polytechnic Institute, Laboratory for the Study of Environmental Degradation of Engineering Materials, 201 Holden Hall, Blacksburg, VA 24061.

From International conference on environmental degradation of engineering materials; Blacksburg, VA, USA (21 Sep 1981).

An experimental technique was developed for evaluating hydrogen (H) absorption and outgassing behavior in uncoated and cadmium electroplated Type 4340 steels of various steel quality. Quantitative relationships were established for the uncoated steels between H behavior, and steel purity and microstructure. The H behavior was explained in terms of H interactions with the defect structures and impurity levels in the steels. Similar H behavior relationships were established for the cadmium electroplated steels. Those results indicated that cadmium does not serve simply as a barrier to H diffusion; the cadmium may also influence H recombination and/or desorption processes.

29869 (CONF-810913—Vol.2, pp 69-81) **Hydrogen diffusion and trapping in metals by a periodic technique.** Robertson, W.M. (Rockwell International Science Center, Thousand Oaks, CA). 1981. Virginia Polytechnic Institute, Laboratory for the Study of Environmental Degradation of Engineering Materials, 201 Holden Hall, Blacksburg, VA 24061.

From International conference on environmental degradation of engineering materials; Blacksburg, VA, USA (21 Sep 1981).

A periodic technique of performing hydrogen diffusion and trapping measurements is described. A square wave pressure input is used, giving a periodic hydrogen flux output. The output is Fourier analyzed to yield the phase lag and amplitude as a function of frequency. An analytic solution to a linearlized model of trapping is presented. The solution is used to obtain values for the trapping parameters of the material. Measurements were made on 1045 steel and nickel-2% thoria, with results that are in good agreement with previous measurements. 8 figures.

29870 (CONF-810913—Vol.2, pp 101-112) **Microstructural effects on H motion in fcc stainless alloys.** Fiore, N.F.; Kargol, J.A. (Univ. of Notre Dame, IN). 1981. Virginia Polytechnic Institute, Laboratory for the Study of Environmental Degradation of Engineering Materials, 201 Holden Hall, Blacksburg, VA 24061.

From International conference on environmental degradation of engineering materials; Blacksburg, VA, USA (21 Sep 1981).

H ingress during galvanostatic cathodic charging and egress after charging have been measured in a series of fcc Fe-base and Ni-base stainless alloys. Both H solubility and H egress rate were functions of alloy composition and states which demonstrated the greatest resistance to hydrogen embrittlement displayed the highest H solubilities and lowest egress rates. A computer model of H-egress, applicable to any alloy, was developed to allow quantitative characterization of these effects. 7 figures.

29871 (CONF-810913—Vol.2, pp 113-120) **Gas-phase hydrogen permeation through alpha zirconium: pressure and geometry dependence.** Gokhale, A.A.; Johnson, D.L. (Univ. of Nebraska, Lincoln). 1981. Virginia Polytechnic Institute, Laboratory for the Study of Environmental Degradation of Engineering Materials, 201 Holden Hall, Blacksburg, VA 24061.

From International conference on environmental degradation of engineering materials; Blacksburg, VA, USA (21 Sep 1981).

Commercially pur zirconium was machined into hollow cylinders of various radius and wall thickness. Steady state permeation rates as well as transient rates of permeation were determined with a quadrupole residual gas analyzer at temperatures between 800° and 1000°K and pressures between 0.025 to 0.25 torr (3.3235 to 33.235 Nm^{-2}). Geometry dependence shows that the permeation is not inversely proportional to the log of radius ratio alone there is an additional constant term which corresponds to the surface resistance to permeation.

29872 (CONF-820205—7) **Electrolysis of aluminum sulfide in molten chlorides.** Minh, N.Q.; Loutfy, R.O.; Yao, N.P. (Argonne National Lab., IL (USA)). 1982. Contract W-31-109-ENG-38. 11p. NTIS, PC A02/MF A01. Order Number DE83010632.

From 111. AIME annual meeting; Dallas, TX, USA (14 Feb 1982).

A laboratory-scale investigation of the production of aluminum by the electrolysis of aluminum sulfide in molten salt electrolytes has been carried out at Argonne National Laboratory. The solubility, electrochemical behavior, and electrolysis of Al_2S_3 were studied in $MgCl_2$-NaCl-KCl eutectic and in the eutectic containing $AlCl_3$ at 1023K.

29873 (DOE/ER/10450—3) **Corrosion Research Center of the University of Minnesota. Progress report, January 1, 1982-December 31, 1982.** Oriani, R.A. (Minnesota Univ., Minneapolis (USA)). Jan 1983. Contract AC02-79ER10450. 246p. NTIS, PC A11/MF A01. Order Number DE83010647.

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Research topics are: high-temperature corrosion and coatings, high polymers, aqueous corrosion, mechanical aspects (fatigue, stress corrosion), and instrumental.

29874 (DOE/ER/10501—7) **Initial stages of oxidation of metals and alloys. Progress report, March 29, 1983.** Blakely, J.M. (Cornell Univ., Ithaca, NY (USA)). Mar 1983. Contract AC02-79ER10501. 18p. NTIS, PC A02/MF A01. Order Number DE83010111.

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Work on the interaction of oxygen with single crystal Ni-Fe alloy surfaces has been continued during the past year. Auger and LEED studies indicate the coexistence of 2-dimensional oxygen-rich and sulphur-rich phases over ranges of temperature, coverage and composition. At a total coverage of 0.5 monolayers the S-O system seems to exhibit a eutectic type behavior. No single mechanism fits the observations on oxidation of Be over the entire range of oxide thickness studied but many features indicate that either electron tunneling or nonlinear ionic diffusion is the rate controlling

step in the continuous film region. Studies of the initial stages of oxidation of Be(0001) by measurement of ellipsometric parameters indicate 3 stages in the process.

29875 **(DOE/ER/12093—T1) High-temperature corrosion of metals in argon-oxygen-chlorine mixture.** McNallan, M.J.; Oh, J.M.; Liang, W.W. (Illinois Univ., Chicago (USA). Dept. of Materials Engineering; Gas Research Inst., Chicago, IL (USA)). 1982. Contract AC02-82ER12093. 10p. NTIS, PC A02/MF A01. Order Number DE83010801.

Mixed oxidation phenomena in chlorine contaminated environments are complicated by the volatility of some of the chloride reaction products. During corrosion under conditions where the oxide is the thermodynamically stable condensed phase, chlorine may penetrate the oxide scale producing corrosion rates which are much higher than those observed during corrosion in uncontaminated oxygen. Depending on the ratio of oxygen to chlorine in the environment, the attack may be characterized by a net mass decrease by formation of volatile chlorides, a net mass increase by formation of oxides, or complex behavior including both. The role of volatile chlorides in the accelerated attack of cobalt, nickel and iron at 1000 K in mixtures containing 1% chlorine is described. 9 figures.

29876 **(DOE/ER/12093—T2) Chlorination of cobalt in an argon-1% oxygen-1% chlorine mixture at 1000°K.** McNallan, M.J.; Kang, C.T.; Liang, W.W. (Illinois Univ., Chicago (USA). Dept. of Materials Engineering; Wisconsin Univ., Milwaukee (USA). Dept. of Materials). 1981. Contract AC02-82ER12093. 14p. NTIS, PC A02/MF A01. Order Number DE83010804.

The corrosion of cobalt metal in a gas mixture containing 1% oxygen and 1% chlorine in argon has been investigated at 1000°K. Under these conditions, the net corrosion reaction is the formation of $CoCl_2(g)$. The rate of corrosion is controlled by transport of $CoCl_2(g)$ in the gas phase, with the effective vapor pressure of $CoCl_2(g)$ at the gas-solid interface being controlled by the reaction between $Co_3O_4(s)$ and the gas when the preformed scale is more than 1.65×10^{-3} g cm^{-3}. When the scale is very thin, the corrosion rate is higher and may approach the maximum theoretical rate for volatilization of solid $CoCl_2$. 3 figures.

29877 **(DOE/ER/70037—T1) Diffusion of oxygen in liquid-metal systems.** Stevenson, D.A. (Stanford Univ., CA (USA). Board of Trustees). Jan 1983. Contract AT03-76ER70037. 15p. NTIS, PC A02/MF A01. Order Number DE83005819.

A research program is described on the topic of kinetic and thermodynamic measurements in liquid metal-oxygen systems. This study has utilized electrochemical cells with solid oxide electrolytes in several different configurations. The principal properties that were studied include: activities of the components in binary metal-metal alloy systems; oxygen solubility and oxygen diffusivity in pure liquid metals and liquid metal alloys; and the free energy of formation of pure metal oxides. The techniques of solid state electrochemistry were developed and the limitations of the techniques were studied. There were sufficient problems with the zirconia electrolytes to motivate a separate study on the degradation of zirconia electrolytes during their use. The electrolytic properties, as measured by complex impedance spectroscopy, was correlated with the microstructure, as evaluated by x-ray, optical microscopy, scanning electron miscoscopy and transmission electron microscopy. Mechanisms for electrolyte degradation were proposed.

29878 **(EPRI-AP—2929) Protective coatings for utility gas turbines. Final report.** (United Technologies Corp., South Windsor, CT (USA)). Mar 1983. 115p. NTIS, PC A06/MF A01. Order Number DE83901926.

Under Task I - Optimization of MCrAlY Coating Systems, two compositions, Co-35Cr-8Al-0.5Y and Ni-20Co-35Cr-8Al-0.5Y were selected as the most hot corrosion resistant compositions in clean as well as vanadium-containing fuels at both 1300/1350°F (704/732°C) and 1650°F (899°C). These compositions along with a PWA-IM6250 baseline, are currently being engine tested under Task II of the program. In Task III - MCrX Coating System Optimization, where M is nickel or cobalt and X is silicon alone or with small amounts of aluminum, two-layered coating systems were evaluated. The inner layer consisted of a MCrAlY composition with a Si-rich, MCrAlY outer layer. The MCrAlY/Si duplex coatings evaluated in Task III burner rig tests were found to be significantly more resistant than the advanced MCrAlY monolayer coatings identified in Task I.

29879 **(GKSS—82/E/33) Density of neutron irradiated and annealed amorphous $Fe_{40}Ni_{40}B_{20}$.** Gerling, R.; Wagner, R. (GKSS-Forschungszentrum Geesthacht G.m.b.H., Geesthacht-Tesperhude (Germany, F.R.)). 1982. 5p. Also published in: Scr. Metall. (1982) v. 16(8) p. 963-967.

Apart from the question about the topology of the (assumed) extended defects causing the swelling, it remains open whether i) these defects can be annealed out by an appropriate thermal treatment with the restoration of the original physical properties of the glassy alloy and ii) whether the amount of swelling of a metallic glass is also fluence dependent as is frequently observed in crystalline materials. In this paper we attempt to answer some of the questions by reporting the density changes of $Fe_{40}Ni_{40}B_{20}$ during various thermal treatments before and after neutron irradiation to different fluences.

29880 **(GKSS—82/E/34) Absence of annealing twins in some austenitic steels during radiation-induced recrystallization.** Vaidya, W.V. (GKSS-Forschungszentrum Geesthacht G.m.b.H., Geesthacht-Tesperhude (Germany, F.R.)). 1982. 6p. Also published in Scr. Metall. (1982) v. 16(7) p. 865-870.

The formation of annealing twins in the austenitic steels of type 1.4970 is found to be dependent on the conditions under which the recrystallization occurs. Whereas under thermal conditions annealing twins do form, they are absent under irradiation. This apparent anomaly is explained by consideration of increased new grain contacts. As the recrystallized grain boundaries keep on migrating under irradiation, stable grain contacts are not established and therefore annealing twins, if they form, become unstable and are removed. Therefore, even though grain size changed from a few hundred to a few thousand nm, annealing twins were not observed. A further reason appears to be the grain growth in the recrystallized areas.

29881 **(IAE—3430/11) Helium migration in alpha-irradiated beryllium.** Vlasov, V.V.; Degal'tsev, Yu.G. (Gosudarstvennyj Komitet po Ispol'zovaniyu Atomnoj Ehnergii SSSR, Moscow. Inst. Atomnoj Ehnergii). 1981. 20p. (In Russian). NTIS (US Sales Only), PC A02/MF A01. Order Number DE83700203.

Mass-spectrometric investigation of the kinetics of helium emission from beryllium specimens has been carried on. Helium was introduced by means of specimen irradiation with alpha particles at the Van de Graaff accelerator. An equation of gaseous diffusion to vacuum from a plate with a limited and localized quantity of diffusing substance has been solved. It is shown by means of a model calculation using an electronic computer that the whole gas emission occurs practically through a surface nearest to a saturation layer. Parameters of temperature dependence of helium diffusion in beryllium in a wide temperature range (650-1150 deg) have been calculated from kinetic curves. It is concluded on the basis of a low value of helium diffusion activation energy in beryllium at annealing temperatures below 900 deg C that there is helium migration over interstitials or in the form of helium atom complexes with vacancies. Considerable increase of helium yield at temperatures above 900 deg C is attributed to increase in the yield surface and reduction of a diffusion path at the expense of "irreversible" structural changes in beryllium.

29882 **(JINR—R-8-81-479) Thermal conductivity of niobium-titanium alloys in mixed state.** Khertsog, R.; Khukhareva, I.S. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of High Energy). 1981. 8p. (In Russian). NTIS (US Sales Only), PC A02/MF A01. Order Number DE83701491.

The behaviour of thermal conductivity in the mixed state is investigated on the alloys of Nb-Ti. The $Nb_{45}Ti_{55}$ alloy with the highest upper critical field of this system and $Nb_{60}Ti_{30}$ with a lower

one were measured. The $Nb_{45}Ti_{55}$ sample was investigated in both coldworked and recrystallized states. It is concluded that in the mixed state the thermal conductivity is strongly dependent on the concentration and the structure of defects. The results are fitted by the theory developed by Caroli and Cyrot for dirty superconductors in proximity of the upper critical field.

29883 **(JINR—R-17-81-561) Magnetic excitation damping in heavy rare earth metals.** Kuzemskij, A.L.; Kristof, F.; Frauenkhajm, T. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1981. 16p. (In Russian). NTIS (US Sales Only), PC A02/MF A01. Order Number DE83700205.

The magnetic susceptibility for the model of heavy rare-earth metals is calculated where the electron-electron interaction and the electron-phonon interaction are taken into account. Using the Green function (GF) technique the mass aperator of the one-magnon GF is calculated and temperature dependence of magnetic excitation damping is investigated.

29884 (KFTI—81-22, pp 82-93) **Vacuum methods for production of niobium superconducting films.** Danilin, B.S.; Makhov, V.I.; Tyablikov, A.V.; Yastrebov, V.G. 1981. (In Russian). NTIS (US Sales Only), PC A07/MF A01.

In General and nuclear physics.

Parameters, characterizing superconducting properties of niobium films are considered. A comparative analysis of vacuum methods of production of niobium superconducting layers (SCL) from the point of view of provision of structural perfectness and stability of their electrophysical properties is carried out on the basis of these parameters. It is shown that development of vacuum methods of SCL production goes in the direction of wider use of high-rate systems of ion spattering and introduction of oilless means of pumping.

29885 (KFTI—81-22, pp 94-95) **Oriented growth of niobium films on the NaCl plane (001).** Bendikov, V.I.; Semenenko, Yu.E.; Shulaev, V.M. 1981. (In Russian). NTIS (US Sales Only), PC A07/MF A01.

In General and nuclear physics.

By methods of electron microscopy studied is the structure of niobium films obtained by the method of electron-beam heating of metal and by condensation of its vapours on NaCl spalling in superhigh vacuum P approximately $4x10^{-9}$ mm Hg. Conditions of formation of epitaxial niobium films in pure cryogenic vacuum are found out. It is shown that the improvement of vacuum conditions (decrease of residual gases pressure) results in the decrease of epitaxial temperature, necessary for oriented growth that is connected in the work with change of mobility of metal adatoms at the decrease of quantity of impurities adsorbed on the surface of growing layer. The effect of the surface state of NaCl spalling (spallings, obtained in vacuum or in air atmosphere with etched surfaces, are studied) on epitaxy appearance is studied.

29886 **(NUREG/CR—3187) Crevice corrosion of titanium alloy TiCode-12 in simulated rock salt brine at 150°C.** Ahn, T.M.; Lee, B.S.; Soo, P. (Brookhaven National Lab., Upton, NY (USA)). Mar 1983. Contract AC02-76CH00016. 26p. (BNL-NUREG—51653). NTIS, PC A03/MF A01 - GPO. Order Number DE83010195.

Titanium alloy TiCode-12 (Ti-0.3 Mo-0.8 Ni) has been shown to suffer from crevice corrosion when exposed to brine at 150°C for periods of several weeks. The nature of the oxide films formed within the crevice has been studied and a mechanism for crevice attack has been proposed.

29887 **(SAND—83-0435C) Incorporation of electrolyte by-products into barrier anodic Al_2O_3 coatings.** Sharp, D.J.; Panitz, J.K.G.; Merrill, R.M.; Haaland, D.M. (Sandia National Labs., Albuquerque, NM (USA)). 1983. Contract AC04-76DP00789. 15p. (CONF-830443—1). NTIS, PC A02/MF A01. Order Number DE83009003.

From Metallurgical coatings conference; San Diego, CA, USA (18 Apr 1983).

Portions are illegible in microfiche products.

We have observed that substantial amounts of electrolyte by-products are incorporated into barrier anodic Al_2O_3 coatings during deposition. The electrolyte used for the process studied consisted of a solution of ammonium tartrate and water which was diluted 1:40 with ethanol. The tartrate concentration in this electrolyte decreases as a function of the amount of aluminium anodized. Fourier transform infrared analysis indicates the coatings produced by this process contain substantial amounts of carboxylates. Auger electron spectroscopy, transmission electron spectroscopy, and other indirect evidence, e.g., Four Transform Infrared Spectroscopy, strongly suggest that the concentration of carboxylates increases with proximity to the outer surface of the coatings. Our results also indicate that these by-products play a substantial role in inhibiting the crystallization of amorphous material present in the coatings. The results of this study support the hypothesis that incorporated electrolyte by-products beneficially contribute to the dielectric properties of barrier anodic coatings. The depletion of tartrate ions from the electrolyte in conjunction with anodic film formation is accompanied by the appearance of acetate and formate. The concentration of these ions increase rapidly and are then depleted along with tartrate late in the bath life. This depletion of the anion species appears to define a practical limit to the area of aluminum which can be anodized in a given volume of the electrolyte without replenishment. 3 figures.

29888 **(UCID—18574-82-4) H-Division. Materials Physics quarterly report, October-December 1982.** (Lawrence Livermore National Lab., CA (USA)). 15 Apr 1983. Contract W-7405-ENG-48. 67p. NTIS, PC A04/MF A01. Order Number DE83011269.

Aluminum has been established as an equation of state standard for the nuclear-driven EOS program, and a series of experiments are planned which will accurately characterize the EOS of aluminum. These include shock-wave off-Hugoniot measurements, a diamond anvil iso- therm, isentropic compression, and nuclear-driven impedance matching experiments. These results will be correlated with theoretical models to produce an accurate global EOS for Aluminum. The effects of strong plasma coupling on spectral limeshapes and Thomson scattering profiles have been studied using a Vlasov-like kinetic equation which incorporates the exact static correlations of the plasma. For wavelengths about equal to an interparticle spacing, the ion peak in the Thomson scattering function can be as much as a factor of two greater than its weak-coupling value. However, the widths of plasma-broadening spectral lines are found to be much less sensitive to strong coupling effects. This suggests that the standard theory of electron line-broadening may be adequate for $\Gamma \leqq 1$. A simple rigid-band model approximation is in qualitative agreement with first-principles electron band theory in predicting phase transitions for Na, Mg, Al, and Si. This has lead to an improved understanding of the rules governing crystal structure stability in simple metals.

29889 **(UCLA—34P290-3) Irradiation-induced precipitation in palladium-base alloys. Third annual progress report, May 1, 1980-January 31, 1981.** Ardell, A.J. (California Univ., Los Angeles (USA). Dept. of Materials Science and Engineering). Feb 1981. Contract AT03-76ER70294. 15p. NTIS, PC A02/MF A01. Order Number DE83010043.

Research on the following topics is reported: irradiation-induced homogeneous precipitation (IIHP) of γ' in Ni-Si; IIP of γ' (Pd_3Fe) in Pd-Fe; IIP in Pd-Cr, Mn and V alloys; IIP in Pd-W and Pd-Mo; and exploratory oxygen ion irradiation of silicate glasses. (DLC)

29890 (UCRL—52000-83-2, pp 11-19) **Diamonds: powerful tools for high-pressure physics.** Feb 1983. NTIS, PC A03/MF A01.

In Energy and Technology Review.

Diamond-anvil high-pressure studies have progressed to the point where they complement shock-wave studies. Because they operate at static high pressure, they permit time-consuming procedures, such as x-ray diffraction measurements for determining crystal structure. The sample material is completely recoverable and the method is adaptable to minute advantage when dealing with rare or hazardous materials. One of our goals in investigating the high-pressure behavior of iridium was to test the theoretical prediction that iridium would exhibit a phase transformation from the face-centered cubic crystal structure at about 9 GPa. Our finding that

no such transformation takes place even at pressures up to 30 GPa will need to be taken into account by physicsts working to improve solid-state theory.

29891 **Proton NMR and magnetic susceptibility study of TiCrsub(1.8)Hsub(x).** Bowman, R.C. Jr. (California Inst. of Tech., Pasadena (USA). Div. of Chemistry and Chemical Engineering); Lynch, J.F.; Johnson, J.R. (Brookhaven National Lab., Upton, NY (USA)). *Materials Letters;* 1: No. 3-4, 122-126(Dec 1982).

Electronic properties of the hexagonal (C-14) and cubic (C-15) allotropes of the TiCrsub(1.8)-hydrogen system have been examined via magnetic susceptibility and proton NMR. Both methods indicate an unusual increase in N(Esub(F)) with increasing H/M. Proton Knight shifts indicate that the N(Esub(F)) increase is due to changes in the d-electron states, although a high concentration of s-electron states at Esub(F) is also present.

29892 **Generation of continuous beams of refractory metal clusters.** Riley, S.J.; Parks, E.K.; Mao, C.R.; Pabo, L.G.; Wexler, S. (Argonne National Lab., IL). *Journal of Physical Chemistry;* 86: No. 20, 3911-3913(30 Sep 1982). Contract W-31-109-ENG-38.

Generation of continuous beams of clusters of refractory metals by a thermal flow surce is described. The source consists of a high-temperature (up to 2000°C) oven for metal vaporization and a liquid-nitrogen-cooled quench cell for condensation and cluster growth. Various flow gases are used to vary the distribution of clusters produced. The operation of the source and the characterization of cluster beams of Al, Cr, Ni, Cu, and Ag are discussed.

29893 **Compatibility of stainless steel with Pb-17 at. pct. Li.** Tortorelli, P.F.; Devan, J.H. (Oak Ridge National Laboratory, P.O. Box X. Oak Ridge, TN 37830). *Journal of Materials for Energy Systems;* 4: No. 2, 78-83(Sep 1982). Contract W-7405-ENG-26.

The corrosion of type 316 stainless steel and Sandvik HT9 by static Pb-17 at. pct Li between 300 and 500 °C was studied. The resulting weight losses were significantly greater than those of these steels in lithium. The corrosive attack was very uniform, and the room-temperature tensile properties of the steels were unaffected by the exposure. The application of molten Pb-17 at. pct Li as a tritium-breeding fluid in conjunction with ferrous alloys in a fusion reactor may be limited to 400 °C or below.

29894 **Electronic structure and surface oxidation of the Haucke compounds $CaNi_5$, YNi_5, $LaNi_5$ and $ThNi_5$.** Weaver, J.H.; Franciosi, A.; Peterman, D.J. (Wisconsin Univ., Stoughton (USA). Synchrotron Radiation Center); Takeshita, T.; Gschneidner, K.A. Jr. (Ames Lab., IA (USA)). *Journal of the Less-Common Metals;* 86: No. 2, 195-202(Aug 1982).

Photoelectron spectroscopy studies of the isomorphic Haucke compounds $CaNi_5$, YNi_5, $LaNi_5$ and $ThNi_5$ show that the valence bands are nearly identical and are dominated by nickel-derived 3d bands. Surface oxidation studies of the compounds were also made, showing that exposure of the surface to oxygen results in oxidized states of both the nickel and the non-nickel species. Thus the widely differing hydrogenation characteristics of these compounds cannot simply be explained by either differences in their electronic structures or a gettering effect of the non-nickel species that keeps the nickel metallic.

29895 **Method of fabricating thin-walled articles of tungsten-nickel-iron alloy.** Hovis, V.M.; Northcutt, W.G. (to Dept. of Energy). US Patent 4,332,617. 1 Jun 1982. Filed date 18 Sep 1979. vp.

PAT-APPL-076528.

The present invention relates to a method for fabricating thinwalled high-density structures of tungsten-nickel-iron alloys. A powdered blend of the selected alloy constituents is plasma sprayed onto a mandrel having the desired article configuration. The sprayed deposit is removed from the mandrel and subjected to liquid phase sintering to provide the alloyed structure. The formation of the thin-walled structure by plasma spraying significantly reduces shrinkage, and cracking while increasing physical properties of the structure over that obtainable by employing previously known powder metallurgical procedures.

29896 **Extrusion-formed uranium-2.4 wt % article with decreased linear thermal expansion and method for making the same.** Anderson, R.C.; Jones, J.M.; Kollie, T.G. US Patent Application 6-381,277. 24 May 1982. 10p. Contract W-7405-ENG-26.

The present invention is directed to the fabrication of an article of uranium-2.4 wt % niobium alloy in which the linear thermal expansion in the direction transverse to the extrusion direction is less than about 0.98% between 22 and 600°C which corresponds to a value greater than the 1.04% provided by previous extrusion operations over the same temperature range. The article with the improved thermal expansion possesses a yield strength at 0.2% offset of at least 400 MPa, an ultimate tensile strength of 1050 MPa, a compressive yield strength of at least 0.2% offset of at least 675 MPa, and an elongation of at least 25% over 25.4 mm/s. To provide this article with the improved thermal expansion, the uranium alloy billet is heated to 630°C and extruded in the alpha phase through a die with a reduction ratio of at least 8.4:1 at a ram speed no greater than 6.8 mm/s. These critical extrusion parameters provide the article with a desired decrease in the linear thermal expansion while maintaining the selected mechanical properties without encountering crystal disruption in the article.

29897 **Fatigue and fracture tolerance evaluation of tall loran tower eyebolts.** Rice, R.C.; Smith, C.E. (Battelle, Columbus Lab, Ohio, USA). *American Society for Testing and Materials, Special Technical Publication;* 424-444(1982). (CONF-8011179—).

From ASTM conference on design of fatigue and fracture resistant structures; Bal Harbour, FL, USA (10 Nov 1980).

Laboratory and analytical fatigue studies were undertaken to assess the criticality of flaws found within several 63.5 mm-diameter communication tower eye-bolts. Fatigue-fracture mechanics analyses provided fatigue life predictions which compared closely with subsequent fatigue experiments on the eyebolts subjected to particular load histories. Results of the study provided the basis for continued usage of many of the used eyebolts and gave specific guidelines on flaw size/location/criticality that were important in setting nondestructive inspection intervals and sensitivity limits. 9 refs.

29898 **Fracture tolerance analysis of the solid rocket booster servo-actuator for the space shuttle.** Smith, S.H.; Ghadiali, N.D.; Zahoor, A.; Wilson, M.R. (Battelle, Columbus Lab, Ohio, USA). *American Society for Testing and Materials, Special Technical Publication;* 445-474(1982). (CONF-8011179—).

From ASTM conference on design of fatigue and fracture resistant structures; Bal Harbour, FL, USA (10 Nov 1980).

The results of an evaluation of the fracture tolerance of three components of the thrust vector control servo-actuator for the solid rocket booster of the space shuttle are described. These components were considered as being potentially fracture critical and therefore having the potential to fall short of a desired service life of 80 missions (that is, a service life factor of 4.0 on a basic service life of 20 missions). Detailed stress analysis of the rod end, cylinder, and feedback link components was accomplished by three-dimensional finite-element stress analysis methods. A dynamic structural model of the feedback system was used to determine the dynamic inertia loads and reactions to apply to the finite-element model of the feedback link. Twenty mission stress spectra consisting of lift-off, boost, re-entry, and water impact mission segments were developed for each component based on dynamic loadings. Most components were determined to have the potential of reaching a service life of 80 missions or service life factor of 4.0. 22 refs.

29899 **Computer-aided modeling of selected sheet metal forming process.** Subramanian, T.L.; Nagpal, V.; Altan, T. (Battelle, Columbus Lab, Ohio, USA). *American Society for Testing and Materials, Special Technical Publication;* 263-278(1982). (CONF-8006247—).

From ASTM symposium on formability of metallic materials - 2000 A.D.; Chicago, IL, USA (24 Jun 1980).

Sheet metal forming processes, such as brake bending, rubber forming, and punch stretch forming, have significant use in manufacturing aircraft, automotive, and appliance parts. Computer-aided modeling and simulation of these processes provides information for production planning, for equipment and tooling selection, and for predicting potential failure during forming. Mathematical models and computer programs are developed to analyze and simulate these widely used sheet forming processes. 8 refs.

29900 **Chemical aspects of iodine-induced stress corrosion cracking of Zircaloys.** Cubicciotti, D.; Jones, R.L.; Syrett, B.C. (EPRI, Palo Alto, CA, USA). *American Society for Testing and Materials, Special Technical Publication;* 146-157(1982). (CONF-800834—).

From 5. international conference on zirconium in the nuclear industry; Boston, MA, USA (4 Aug 1980).

The thermodynamics of the zirconium-iodine system are summarized. Thermodynamic information for iodine chemisorbed on zirconium surfaces is also presented. These thermochemical results are used to analyze chemical behavior in situations related to stress corrosion cracking (SCC). Cracking initiation sites in commercial Zircaloy tubing were found to be associated with impurities (iron, aluminum, silicon, and chromium) in the Zircaloy surface in microsurface examination of failures produced in iodine-induced SCC tests. It is suggested that the impurity site may react with iodine to form a locally embrittled region that fails under stress and acts as a crack initiator.

29901 **Temperature dependence of x-ray photoemission spectra: Fermi-sea recoil effects.** Satpathy, S.; Dow, J.D. (Univ. of Illinois, Urbana). *Solid State Communications;* **42**: No. 9, 637-639(1982).

The effect of temperature on the asymmetry of the x-ray photoemission lineshape of a metal or heavily doped semiconductor is evaluated using a simple one-dimensional model to describe the conduction electrons. Temperature dependent recoil processes are found to be significant for k/sub B/T > E/sub F//4, and could be observed in heavily-doped semiconductors, but not in metals at room temperature.

29902 **Internally consistent model for radiation-induced void swelling.** Nichols, F.A.; Liu, Y.Y. (Argonne Natl Lab, IL, USA). *Annual Book of ASTM Standards;* 145-165(1981). (CONF-800609—).

From 10. international symposium on effects of radiation on materials; Savannah, GA, USA (3 Jun 1980).

Most previous analytical models for radiation-induced void swelling employed reaction rate theory in which all concentrations were averaged out. Here a unified, internally consistent analytical approach is presented which incorporates the presence of dislocations, voids, and grain boundaries each with their own spatially varying diffusional fields. The results show large variations in sink strength Z-factors, usually treated as constants, significant variations in the void swelling bias factor, and quantitative levels of bias about an order of magnitude larger than most previous estimates. Good qualitative agreement is shown with available data, consistent with current concepts of close-pair annihilation in high-energy damage cascades.

29903 **Fracture resistance of HT-9 after irradiation at elevated temperature.** Smidt, F.A. Jr.; Hawthorne, J.R.; Provenzano, V. (US Nav Res Lab, Washington, DC, USA). *Annual Book of ASTM Standards;* 269-284(1981). (CONF-800609—).

From 10. international symposium on effects of radiation on materials; Savannah, GA, USA (3 Jun 1980).

HT-9, a 12 percent chromium martensitic stainless steel of interest for use in ducts for fast reactors and as a first-wall material in magnetic fusion reactors, was irradiated in the Experimental Breeder Reactor II to obtain the first evaluation of fracture toughness changes produced by high-temperature/high-fluence irradiation in this class of alloy. Charpy V-notch, precracked Charpy, and tension specimens were used to evaluate the tensile and fracture behavior of this steel in the as-received condition, after 5000 h of aging at 427 and 538/degree/C and a 108 deg C shift in the ductile-to-brittle transition after irradiation at 419/degree/and a 108 deg C shift in the ductile-to-brittle transition after irradiation at 419/degree/C. Possible mechanisms for the observed response are discussed.

29904 **Tensile properties of neutron-irradiated Nimonic PE16.** Bajaj, R.; Shogan, R.P.; DeFlitch, C.; Fish, R.L.; Paxton, M.M.; Bleiberg, M.L. (Westinghouse Electr Corp, Madison, PA, USA). *American Society for Testing and Materials, Special Technical Publication;* 326-351(1981). (CONF-800609—).

From 10. international symposium on effects of radiation on materials; Savannah, GA, USA (3 Jun 1980).

Tension specimens of Nimonic PE16 in the solution-treated and aged condition were irradiated in the experimental breeder reactor II to a maximum fluence of approximately 7 X 10^{22} neutrons/cm^2 (E>0.1 MeV) over a temperature range of 450 to 735 degree C. Tension tests were conducted at 232 degree C (fuel handling temperature), temperature to simulate transient reactor events. The alloy exhibited high strength and adequate ductility at 232 degree C. At the irradiation temperature, the strength remained high; however, a loss in ductility occurred. No significant loss in grain boundary fracture stress was observed in the tests showing low ductility values. The loss in ductility can be explained by reduced differential between ultimate tensile strength and the yield stress.

29905 **Effects of neutron irradiation on fatigue and creep-fatigue crack propagation in type 316 stainless steel at 649 degree C produced no significant effect on the crack propagation rate when compared with unirradiated steel tested at 649 degree C.** Michel, D.J.; Smith, H.H. (US Nav Res Lab, Washington, DC, USA). *American Society for Testing and Materials, Special Technical Publication;* 352-374(1981). (CONF-800609—).

From 10. international symposium on effects of radiation on materials; Savannah, GA, USA (3 Jun 1980).

The fatigue and creep-fatigue crack propagation performance of Type 316 stainless steel has been investigated following fast neutron (n) irradiation. The purpose was to evaluate the effects of neutron fluence and temperature on the crack propagation resistance and failure mode of the steel. Results are presented from fatigue tests of the annealed steel that were irradiated at 649 degree C Scanning electron microscope examination of the fracture surfaces of the tested specimens revealed that the failure mode of the specimens which exhibited increased crack propagation rates was primarily intergranular while a transgranular mode was observed for specimens with lower crack propagation rates. The results point toward a synergistic relationship between thermomechanical history, precipitate formation, and hold time effects as the responsible mechanism for the crack propagation performance.

29906 **Microstructural interpretation of the fluence and temperature dependence of the mechanical properties of irradiated AISI 316.** Johnson, G.D.; Garner, F.A.; Brager, H.R.; Fish, R.L. (Hanford Eng Dev Lab, Richland, WA, USA). *American Society for Testing and Materials, Special Technical Publication;* 393-412(1981). (CONF-800609—).

From 10. international symposium on effects of radiation on materials; Savannah, GA, USA (3 Jun 1980).

The effects of neutron irradiation on the mechanical properties of annealed and 20 perecent cold-worked AISI 316 irradiated in the experimental breeder reactor II were determined for the temperature regime of 370 to 760 degree C for fluences up to 8.4 X 10^{22} neutrons (n)/cm^2 (E>0.1 MeV). Observations are explained in terms of the fluence and temperature dependence of the irradiation-induced microstructure. Very good agreement between the observed data and calculated strengths was obtained for both solution-annealed and cold-worked AISI 316 through the use of simple hardening expressions for each type of microstructural defect.

29907 **Coarse slip processes and crack propagation in irradiated stainless steel.** Horton, J.A.; Jesser, W.A. (Univ of Va, Charlottesville, USA). *American Society for Testing and Materials, Special Technical Publication;* 413-430(1981). (CONF-800609—).

From 10. international symposium on effects of radiation on materials; Savannah, GA, USA (3 Jun 1980).

Unirradiated, neutron-irradiated, and in situ helium ion-irradiated stainless steel specimens have been tension-tested in high-voltage electron microscope at temperatures from 25 to 600 degrees C. The relative ductility of these specimens was assessed as a function of temperature and correlated with transmission electron microscope observations of crack-tip angles, plastic zone width, and crack propagation characteristics. In neutron-irradiated specimens tested at 25 to 400 degree C, the cracks propagated along channels and slipbands. The fracture surface of the 400 degree C test specimen showed coarse slip steps up to 5/mu/m wide. Coarse slip was sometimes followed by homogeneous slip on different slip systems. The presence of large voids or helium bubbles seems to prevent cracks from following channels and to cause them instead to follow the zigzag path typical in ductile specimens.

29908 **Microstructural development in dual-ion-bombarded 316 stainless steel.** Wood, S.; Spitznagel, J.A.; Choyke, W.J.; Doyle, N.J.; McGruer, J.N.; Townsend, J.R. (Westinghouse Electr Corp, Pittsburgh, PA, USA). *American Society for Testing and Materials, Special Technical Publication;* 455-469(1981). (CONF-800609—).

From 10. international symposium on effects of radiation on materials; Savannah, GA, USA (3 Jun 1980).

29909 **Point-defect clustering in the presence of mobile helium and immobile traps.** Hall, B.O. (Argonne Natl Lab, Idaho Falls, Idaho, USA). *American Society for Testing and Materials, Special Technical Publication;* 512-527(1981). (CONF-800609—).

From 10. international symposium on effects of radiation on materials; Savannah, GA, USA (3 Jun 1980).

A time-dependent model for vacancy and interstitial clustering during irradiation has been modified to include both mobile helium and immobile (solute) traps. The helium interacts only with the vacancies; the solute atoms can trap either type of point defect. With parameters appropriate for nickel-silicon alloys, concentrations of vacancies, interstitials, divacancies, diinterstitials, interstitial helium, vacancy-helium pairs, vacancy-solute pairs, and interstitial-source pairs were calculated. Various vacancy clustering regimes identified, and experimental implications of the results are discussed.

29910 **Swelling in reactor-conditioned nickel-ion irradiated nimonic PE16.** Bajaj, R.; Diamond, S.; Chickering, R.W.; Bleiberg, M.L. (Westinghouse Electr Corp, Madison, PA, USA). *American Society for Testing and Materials, Special Technical Publication;* 541-561(1981). (CONF-800609—).

From 10. international symposium on effects of radiation on materials; Savannah, GA, USA (3 Jun 1980).

Nimonic PE16 solution treated and aged and neutron irradiated at three temperatures to a fluence up to 5.9 X 10/sup 22/ n/cm/sup 2/ was bombarded to an additional nominal nickel ion dose of 150 displacements per atom (dpa) at various temperatures. The swelling determined by transmission electron microscopy is described and comparisons are made with results obtained from ion bombardments of virgin material and high-fluence neutron irradiated material.

29911 **Gamma prime coarsening and redistribution in nimonic PE16.** Gelles, D.S. (Hanford Eng Dev Lab, Richland, WA, USA). *American Society for Testing and Materials, Special Technical Publication;* 562-582(1981). (CONF-800609—).

From 10. international symposium on effects of radiation on materials; Savannah, GA, USA (3 Jun 1980).

Gamma prime precipitate microstructures have been examined in solution-treated 10/sup PE16 following irradiation to 6 and 10 X 10^{22} neutrons/cm^2 (E>0.1 MeV) over the temperature range 425 to 650 degree C and their irradiation behavior has been compared with their thermal aging behavior at 750 and 850 degree C. The precipitate structures are deduced to result from the competing processes of irradiation-enhanced Ostwald coarsening and solute segregation by point-defect drag to point-defect sinks. On the basis of the foregoing results, it is possible to quantitatively describe the response of precipitation-hardened alloys during fast neutron irradiation.

29912 **Irradiation-induced precipitation in binary palladium-refractory metal alloys.** Weaver, L.; Ardell, A.J. (Univ of Calif, Los Angeles, USA). *American Society for Testing and Materials, Special Technical Publication;* 610-626(1981). (CONF-800609—).

From 10. international symposium on effects of radiation on materials; Savannah, GA, USA (3 Jun 1980).

A study of irradiation-induced precipitation (IIP) has been carried out on a series of palladium-based alloys containing tungsten, molybdenum, tantalum and niobium, irradiated with 400-keV protons over the temperature range 65 to 750 degrees C. The microstructures observed are described in detail and discussed in the light of recently proposed mechanisms of IIP. It is concluded that the IIP of tungsten and molybdenum at interstitial dislocation loops must occur as a consequence of strong interstitial solute atom binding, and that the observation of this phenomenon in the percent tungsten alloy represents the first clear-cut example of such binding in an alloy containing an oversized solute.

29913 **Study of radiation damage produced in thinned specimens of 316 stainless steel by energetic helium ions.** Horton, L.L.; Jesser, W.A. (Univ of Va, Charlottesville, USA). *American Society for Testing and Materials, Special Technical Publication;* 642-653(1981). (CONF-800609—).

From 10. international symposium on effects of radiation on materials; Savannah, GA, USA (3 Jun 1980).

The aim is to help ascertain the relative importance of the thin-film effects by studying how the evolution of radiation damage depends on specimen thickness. In order to better understand how specimen thickness affects the radiation damage process, in situ high-voltage electron microscope irradiations with helium ions were performed on 316 stainless steel foils containing a thickness gradient. The development of damage from the bubble formation stage to the surface blistering or exfoliation stage or both was observed by static and dynamic recordings techniques. The results of these thin-film irradiations are compared with the results of bulk irradiations and discussed in terms of the possible mechanisms responsible for the phenomena.

29914 **Irradiated materials measurement technology.** Gilbert, E.R.; Chin, B.A. (Westinghouse Hanford Co, Richland, WA, USA). *American Society for Testing and Materials, Special Technical Publication;* 665-679(1981). (CONF-800609—).

From 10. international symposium on effects of radiation on materials; Savannah, GA, USA (3 Jun 1980).

In-reactor measurement technology has advanced to the point where experimental programs are routinely testing hundreds of creep specimens. These specimens include numerous developmental as well as commerical alloys. The tests encompass the operating temperatures, pressures, stresses, and neutron fluences in liquid metal fast breeder reactor cores. This report describes the test vechicles and the measurement tecniques used to generate the data.

29915 **Reduction of irradiation-induced creep and swelling in AISI 316 by compositional modifications.** Bates, J.F.; Powell, R.W.; Gilbert, E.R. (Hanford Eng Dev Lab, Richland, WA, USA). *American Society for Testing and Materials, Special Technical Publication;* 713-734(1981). (CONF-800609—).

From 10. international symposium on effects of radiation on materials; Savannah, GA, USA (3 Jun 1980).

Studies involving high fluence irradiations of compositionally modified AISI 316 stainless steel have demonstrated that the irradiation-induced creep and swelling of this alloy can be modified through a selective choice of alloying elements. Irradiation-induced creep strain of AISI 316, is, in general, reduced by the same elements which reduce irradiation-induced swelling. It was found that the compositional dependence of both swelling and creep in this alloy system can be described through a description of the screening of dislocation strain fields. Compositional modifications which increase the mobility of the screening agents or allow the formation

of more effective screeing agents will decrease the swelling and irradiation creep. This screening results in a decrease in the interstitial-dislocation bias, which results in lower swelling and in-reactor creep.

29916 **Gaseous hydrogen embrittlement of steel - the rate controlling process.** Pasco, R.W. (Syracuse Univ., NY); Ficalora, P.J. *Scripta Metallurgica;* **15**: No. 9, 1019-1022(1981).

A simple model has been advanced relating Stage II crack growth rates to adsorption kinetics. Crack growth kinetics are related to a critical volume concentration, c* (m/sup -3/), through which the crack advances once this concentration is attained. The shift in critical temperatures, T/sub m/ and T/sub c/, for the lower strength steel is attributed to an increase in desorption kinetics resulting from the effect of plastic strain at the crack tip. The difference in crack growth rates for the two different steels at the same pressure and temperature (in the low T region) is logically attributed to different critical concentrations, c*. The critical concentration, c*, is greater for the lower strength steel.

29917 **The formation of solid solution oxides during internal oxidation.** Whittle, D.P. (Lawrence Berkeley Lab., CA); Gesmundo, G.; Bastow, B.D.; Wood, G.C. *Oxidation of Metals;* **16**: No. 1-2, 159-174(1981). Contract W-7405-ENG-48.

The diffusion processes occurring when binary alloys react with oxygen to form an oxide that contains both alloy components in solid solution, either exclusively as internal oxide or in combination with a surface scale, have been analyzed and compared with experimental results for Fe-Mn and Ni-Co alloys. The experimental results available for the Fe-Mn system were obtained under conditions of exclusive internal oxidation, and good agreement was obtained between calculated and experimental results. In the Ni-Co system, a surface scale and a zone of internal oxidation develop. Agreement between calculated and experimental depths of internal penetration is acceptable if the diffusivity of oxygen in the alloy is 3.8×10^{-6} cm²/sec at 1100°C. Agreement between calculated and experimental concentration profiles is not very good.

29918 **An electrochemical study of the solubility and diffusivity of oxygen in the respective liquid metals indium, gallium, antimony and bismuth.** Heshmatpour, B.; Stevenson, D.A. (Stanford Univ., CA). *Journal of Electroanalytical Chemistry;* **130**: 47-55(1981). Contract AM03-76SF00326.

Diffusivities, solubilities and activity coefficients of oxygen were measured in the liquid metals indium, gallium, antimony and bismuth. Solid electrolyte electrochemical cells were used with a potentiostatic titration technique, and the temperature interval investigated was between 750 and 1000°C. The results are compared with previously reported values, with particularly large differences noted for the saturation solubility values.

29919 **Detection of protective oxide layers on Cr formed by exposure to air by stem-ELS method.** Watari, F. (Arizona State Univ., Tempe). *Surface Science;* **110**: 111-119(1981). Contract AC02-76ER02995.

Relatively thick (1000 A) and very thin (30 A) Cr specimens have been observed with scanning transmission electron microscopy (STEM) and energy-loss spectroscopy (ELS). They show marked differences in both diffraction (selected area electron diffraction and microdiffraction) and composition (ELS) data. The extra 2.5 A ring in SAED and oxygen K edge loss peak in ELS are attributed to the protective oxide layer formed at the surface of Cr by exposure to air at 25°C. The average thickness of the layer is estimated to be about 10 A.

29920 **Physics of ultra-pure germanium.** Haller, E.E.; Hansen, W.L.; Goulding, F.S. (Lawrence Berkeley Lab., CA). *Advances in Physics;* **30**: No. 1, 93-138(1981). Contract W-7405-ENG-48.

A broad review of the physics of point defects, i.e., electrically active and neutral impurities and impurity complexes is given. Basic material science which is crucial for understanding the physics is summarized in an introductory section. It is followed by the detailed description of the novel measurement techniques - photothermal ionization spectroscopy, high-Q electron paramagnetic resonance and deep level spectroscopy. These spectroscopic techniques have had a profound impact on the investigations of ultra-pure germanium. The major part of this work deals with the physics of point defects in ultra-pure germanium. The high purity of this semiconductor allows the undisturbed observation of highly excited bound states of shallow donors and acceptors. Many new previously unknown acceptor and donor centres have been discovered in ultra-pure germanium. The nature of several of these centers can be understood in terms of a complex consisting of two impurities - a light interstitial atom (for example, hydrogen or lithium) tunnelling between four identical real space positions in the vicinity of a substitutional impurity (for example, carbon, silicon, oxygen, or copper), or a defect (for example, divacancy). The motion of the tunnelling impurity is shown to influence the electronic structure of the complex leading to a symmetry of higher order than tetrahedral. Experimental results are presented which are fully consistent with the tunnelling model. Besides the review of recently published results, new findings on the solubility of substitional copper in ultra-pure crystals grown under a variety of conditions and on the two donors lithium D(Li) and lithium-oxygen D(Li, O) are presented.

29921 **Imaging metal surfaces by pulsed-laser-stimulated field desorption of field adsorbed atoms.** Kellogg, G.L. (Sandia National Labs., Albuquerque, NM); Tsong, T.T. *Surface Science;* **110**: L599-L605(1981). Contract AC04-76DP00789;AC02-81ER10857.

Atomic images of Pt and Mo surfaces have been obtained using pulsed laser stimulated field desorption of field adsorbed atoms. The resolution of the desorption images is slightly inferior to low temperature field ion images. The direct correspondence of the images produced by thermally desorbed field adsorbed atoms with field ion images supports previous calculations suggesting apex site field adsorption of image gas atoms on field emitter surfaces.

29922 **In situ observations of the formation of plastic zone ahead of a crack tip in copper.** Kobayashi, S.; Ohr, S.M. (Oak Ridge National Lab., TN). *Scripta Metallurgica;* **15**: 343-348(1981). Contract W-7405-ENG-26.

In situ electron microscopy has been shown to be a useful technique to study the structure of the plastic zone ahead of a crack. It was expected that the detailed structure of the plastic zone ahead of a crack depended on the stacking fault energy of the materials, we have extended the studies to nickel and copper. Although nickel was believed to be a metal of high stacking fault energy, the plastic zone was in the form of a linear array of dislocations and the dislocations were often split into partial dislocations. From the contrast analysis, it was found that all the partials did not lie on a single plane but on parallel planes and hence the stacking faults were overlapping. It was concluded that the overlapping stacking faults represented a twin lamella. The aim of the present work is to study the structure of the plastic zone in copper and to examine further the possibility of twin formation in the plastic zone.

29923 **Cyclic inelastic deformation aspects of fatigue-crack-growth analysis.** Leis, B.N.; Zahoor, A. (Battelle, Columbus Lab, Ohio, USA). *American Society for Testing and Materials, Special Technical Publication;* 65-96(1980). (CONF-7905104—).

From 12. annual symposium on fracture mechanics; St Louis, MO, USA (21 May 1979).

This paper concentrates on a J-integral analysis of fatigue crack growth. Data on cyclic plasticity are analyzed showing that there are limitations to the usefulness of the deformation theory in applications to cyclic plasticity. 56 refs.

29924 **Stress intensity factor due to parallel impact loading of the faces of a crack.** Abou-Sayed, I.S.; Burgers, P.; Freund, L.B. (Battelle, Columbus Lab, Ohio, USA). *American Society for Testing and Materials, Special Technical Publication;* 164-173(1980). (CONF-7905104—).

From 12. annual symposium on fracture mechanics; St Louis, MO, USA (21 May 1979).

A method for assessment of the dynamic stress intensity factor and crack propagation is evaluated. The plane-strain re-

sponse of an unbounded elastic body subjected to a pair of concentrated forces suddenly applied to the crack at some distance from the crack tip is determined. 13 refs.

29925 **An interactive damage equation for creep-fatigue interaction.** Majumdar, S.; Maiya, P.S. (Argonne National Lab., IL). pp 101-109 of Mechanical behaviour of materials. Miller, K.J.; Smith, R.F. (eds.). Oxford, England; Pergamon Press (Aug 1979).

Microstructural evidence has been presented to indicate that the crack-growth rate in Type 304 stainless steel at 593°C is accelerated by the presence of grain-boundary cavities which are introduced by the application of tensile-hold cycles. It has also been observed that the introduction of compressive hold in a specimen which has previously been subjected to cycles with tensile hold can reduce the crack growth rate to that of a specimen subjected to continuous cycling with no hold time. Interactive damage-rate equations have been proposed that qualitatively take into account the observed crack growth behavior. These equations represent a generalization of a set of equations proposed earlier. The predictions of life and crack growth history based on these equations are in close agreement with experimental observations.

29926 **Fundamental mechanisms of the erosive wear of ductile metals by solid particles.** Finnie, I.; Levy, A.; McFadden, D.H. pp 36-58 of Erosion: prevention and useful applications, ASTM STP 664. Adler, W.F. (ed.). Philadelphia, PA; American Society for Testing and Materials (1979).

A brief survey is presented of the mechanisms which have been proposed for the erosion of ductile metals by solid particles. After reviewing these and examining scanning electron microscope photographs, it is concluded that a ductile cutting mode applies when the velocity vector of the eroding particle makes an angle of less than about 45 deg with the surface. Above this angle the removal process appears to involve quite different mechanisms. An earlier analysis of the cutting mechanism is reexamined and shown to predict many features of the erosion process. In particular, the roles of particle velocity, elevated temperatures, and material properties are discussed. Some preliminary results are presented for erosion at higher angles, and possible mechanisms for material removal are discussed. Finally, some suggestions are made for future directions in erosion research in view of the current interest in coal-hydrogenation processes.

29927 **(UCRL-Trans—11818) Contribution to the question of laboratory mills.** Fritsch, P; Fritsch, W.; Mehmel, M. Translation of *Keramische Zeitschrift ;* No. 8, 467-485(1963). Contract W-7405-ENG-48. 10p. NTIS, PC A02/MF A01. Order Number DE83007183.

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The article gives an insight into the possibilities of improving the grinding process, and presents a series of factors which are decisive for the rate of grinding. Suggestions are given for further developments.

3602 Ceramics, Cermets, And Refractories

REFER ALSO TO CITATION(S) 28815, 29220, 29225, 29571, 29710, 29785, 29787, 30885

29928 **(CONF-820547—17) Effect of Fe^{2+} substitutional impurities on the stability of a $\Sigma = 5$, (100) CSL twist boundary in MgO: a theoretical study.** Wolf, D. (Argonne National Lab., IL (USA)). Jun 1982. Contract W-31-109-ENG-38. 20p. NTIS, PC A02/MF A01. Order Number DE83009015.

From 84. annual meeting of the American Ceramic Society; Cincinnati, OH, USA (2 May 1982).

The binding energy of a substitutional Fe^{2+} impurity in MgO to both the free (100) surface and to a $\Sigma = 5$, (100) CSL twist boundary has been calculated to be -0.92 eV and -1.05 eV, respectively. For most temperatures the impurity must therefore be considered as trapped once it has diffused to the planar defect. Interestingly, however, it is found that the Fe^{2+} impurity has to approach either the surface or the interface as closely as one lattice plane before being affected by the presence of the planar defect. Results for the free surface are in very good agreement with recent calculations of Colbourn and Mackrodt.

29929 **(CONF-8209111—) Energy Materials Coordinating Committee (EMACC) contractors meeting on problems and opportunities in structural ceramics.** (Department of Energy, Washington, DC (USA). Div. of Materials Sciences). Apr 1983. 290p. NTIS, PC A13/MF A01. Order Number DE83010175.

From Energy Materials Coordinating Committee contractor's meeting on problems and opportunity structural ceramics; Germantown, MD, USA (29 Sep 1982).

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This report consists mainly of viewographs and summaries of DOE and other programs on structural ceramics. Applications include heat engines, fusion reactors, solar absorbers, heat exchangers, coal conversion, turbines, material substitution, etc. Research centers and their capabilities are described. Panel discussions on fabrication reliability, market, ceramic producers and engine manufacturers, and conclusions are summarized. (DLC)

29930 **(DOE/ER/12052—1) Study of the kinetics and thermodynamics of hydrogen in Pd-based alloys. Progress report.** McLellan, R.B. (Rice Univ., Houston, TX (USA)). 1983. Contract AS05-82ER12052. 3p. NTIS, PC A02/MF A01. Order Number DE83010137.

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A brief summary is presented of studies of the thermodynamics of hydrogen in Pd-base alloy, of the interaction between H atoms and vacancies in noble metals, of the kinetics of the H-Fe system, and of surface interactions in diffusivity and solubility measurements of H in metals. (DLC)

29931 **(JINR—R-13-81-794) Reflection intensities of photons in the n-th diffraction order for crystal planes of quartz. LiF, Ge and Si.** Polers, A.; Shchornak, G. (Joint Inst. for Nuclear Research, Dubna (USSR). Dept. of New Acceleration Methods). 1981. 8p. (In Russian). NTIS (US Sales Only), PC A02/MF A01. Order Number DE83700204.

Using the universal X-ray diffractometer HZG-4 for the Mo-Ksub(α) X-rays the reflex intensities of plane crystals of Si/100/ are measured for different diffraction orders. For the received spectra the pure diffraction peak areas and their product with the corresponding effect to background ratio are determined. For Ge and Si one can observe clear minima of the reflex intensities, but for quartz and LiF an almost monotonous decrease. of the reflex intensities by increasing diffraction order seems characteristic. From the received results one can get conclusions about the possible region for measurements of X-ray energies by means of Bragg diffraction spectrometers.

29932 **Muon spin rotation study on magnetite.** Boekema, C. (Los Alamos National Lab., NM); Brabers, V.A.M.; Denison, A.B.; Heffner, R.H.; Hutson, R.L.; Leon, M.; Olsen, C.E.; Schillaci, M.E. *Muon SR Newsletter;* No. 28, 1466-1473(24 Dec 1982).

Muon spin rotation (μSR) results on synthetic single crystals of magnetite (Fe_3O_4) support the idea of muon bond formation in oxides. The anomaly in the temperature dependence of the μSR may be attributed to the existence of molecular polarons in the Verwey transition temperature region.

29933 **Thermal conductivity of UO_2 vapor.** Frurip, D.J.; Fink, J.K. (Argonne National Lab., IL (USA). Chemical Engineering Div.). *Journal of Nuclear Materials;* **110**: No. 2/3, 309-316(Oct 1982).

The thermal conductivity, lambda of a saturated vapor over UOsub(1.96) is calculated in the temperature range 3000-6000 K. The calculation shows that the contribution to lambda from the transport of reaction enthalpy dominates all other contributions. All possible reactions of the gaseous species UO_3, UO_2, UO, U, O, and O_2 are included in the calculation. We fit the total thermal conductivity to an empirical equation.

29934 Chemical diffusivity of oxygen in UOsub(2-x). Olander, D.R. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.; California Univ., Berkeley (USA). Dept. of Nuclear Engineering). *Journal of Nuclear Materials;* **110**: No. 2/3, 352(Oct 1982).

Published in summary form only; Letter-to-the-editor.

29935 Method of producing novel silicon carbide articles. Milewski, J.V. US Patent Application 6-389,802. 18 Jun 1982. 16p. Contract W-7405-ENG-36.

A method of producing articles comprising reaction-bonded silicon carbide (SiC) and graphite (and/or carbon) is given. The process converts the graphite (and/or carbon) in situ to SiC, thus providing the capability of economically obtaining articles made up wholly or partially of SiC having any size and shape in which graphite (and/or carbon) can be found or made. When the produced articles are made of an inner graphite (and/or carbon) substrate to which SiC is reaction bonded, these articles distinguish SiC-coated graphite articles found in the prior art by the feature of a strong bond having a gradual (as opposed to a sharply defined) interface which extends over a distance of mils. A method for forming SiC whisker-reinforced ceramic matrices is also given. The whisker-reinforced articles comprise SiC whiskers which substantially retain their structural integrity.

29936 Microstructure of Synroc. Cousens, D.R.; Myhra, S.; Penrose, J.; Segall, R.L.; Smart, R.St.C.; Turner, P.S. (Griffith Univ., Queensland, Australia). pp 309-318 of Scientific basis for nuclear waste management V. Lutze, W. (ed.). New York, NY; North-Holland (1982).

From 5. international symposium on the scientific basis for radioactive waste management; Berlin, F.R. Germany (7 Jun 1982).

An investigation of the microstructure of Synroc B prepared by the oxide route has shown that minor phases are present to a significant extent. Among these is a modified form of zirconolite which consists of an intergrowth of normal zirconolite with a derivative structure of the same phase. This provides an additional mechanism for the flexible uptake of foreign elements into zirconolite. Synroc C is a complex multiphase material and radwaste additions significantly affect the final form of the titanate ceramic. These modifications of Synroc B may be beneficial, the finer grain and phase size seem advantageous, on the other hand if there were segregation of a critical waste element into a soluble miner phase this could be a serious problem. In Synroc B and Synroc C the distribution of phases shows systematic minor variation on the scale of tens of microns, probably as the result of initial local compositional variations in the mixture of oxide starting materials.

29937 SIMS depth profiling studies of sphene-based ceramics and glass ceramics leached in synthetic groundwater. Hayward, P.J.; Hocking, W.H.; Doern, F.E.; Cecchetto, E.V. (Atomic Energy of Canada Limited, Pinawa, Manitoba). pp 319-328 of Scientific basis for nuclear waste management V. Lutze, W. (ed.). New York, NY; Horth-Holland (1982).

From 5. international symposium on the scientific basis for radioactive waste management; Berlin, F.R. Germany (7 Jun 1982).

Glass ceramics and ceramics based on the mineral sphene ($CaTiSiO_5$) are being developed to host the wastes arising from possible future CANDU fuel reprocessing. Results from leaching tests in deionized water and in synthetic groundwater indicate that these materials are highly durable. Secondary Ion Mass Spectrometry (SIMS) depth profiling of leached specimens suggests that leaching in the glass ceramics is predominantly confined to the glass phase. The high ionic strength and composition of the groundwater have a significant passivating effect on leaching and surface alteration phenomena, and encourage the precipitation of new phases on the ceramic surface. Leaching results, scanning electron microscope (SEM) observations and SIMS depth profile measurements are compared and discussed.

29938 Leaching of natural and synthetic sphene and perovskite. Metson, J.B. (Univ. of Western Ontario, London); Bancroft, G.M.; Kanetkar, S.M.; Nesbitt, H.W.; Fyfe, W.S.; Hayward, P.J. pp 329-338 of Scientific basis for nuclear waste management V. Lutze, W. (ed.). New York, NY; Horth-Holland (1982).

From 5. international symposium on the scientific basis for radioactive waste management; Berlin, F.R. Germany (7 Jun 1982).

The leach rates of natural and synthetic sphenes in deionized water are initially between 10^{-8} and 10^{-9} kg m^{-2} s^{-1} and fall by an order of magnitude over 28 days. Natural crystalline and ceramic, and $CaTiSiO_5$ glass show maximum leach rate differences of less than an order of magnitude over the 60-day time interval considered here. Perovskite leach rates from synthetic and naturally occurring single crystals, show similar initial rates to the more resistant sphenes and a parrallel decline in leach rate with time. Small but consistent weight gains are observed for ceramic samples leached in quartz-saturated/500 ppM Ca^{2+} solutions. Weight gains in sphene leaching experiments in a synthetic saline groundwater were observed. Surface studies on a leached $CaTiSiO_5$ glass show rapid loss of Ca^{2+} and Si^{4+} from the surface of the glass. After 8 days in deionized water at 90°C the zone of calcium and silica depletion extends to a depth of at least 200 nm. There is evidence that the initial selectively leached layer, as observed after 1 to 24 hours leaching, has been replaced by a reprecipitated TiO_2 layer of much greater depth after 8 days leaching. The leaching of crystalline sphenes in deionized water could be expected to follow the same path, as similar bulk leach rates results are observed. For natural crystalline materials however, our experiments indicate that the problem of obtaining a consistent surface on polished discs makes it difficult to resolve whether the same behavior occurs. Fractured surfaces, used extensively in surface studies of glass leaching, minimize surface modification and offer better prospects for characterization by surface techniques.

29939 Study of radiation effects in curium-doped $Gd_2Ti_2O_7$ (pyrochlore) and $CaZrTi_2O_7$ (zironolite). Wald, J.W. (Pacific Northwest Lab., Richland, WA); Offermann, P. pp 369-378 of Scientific basis for nuclear waste management V. Lutze, W. (ed.). New York, NY; Horth-Holland (1982). Contract AC06-76RL01830.

From 5. international symposium on the scientific basis for radioactive waste management; Berlin, F.R. Germany (7 Jun 1982).

The present work shows that radiation damage in growth in $Gd_2Ti_2O_7$ and $CaZrTi_2O_7$ follows an expected exponential relationship of the form $\Delta V/V_0 = A[1-\exp(-BD)]$ based on XRD lattice swelling, while in $CaZrTi_2O_7$, macroscopic swelling was about 1.5 times greater than lattice swelling at the last measurable levels. Estimated values of unit cell volume and density swelling atsaturation for $CaZrTi_2O_7$ are 7.6% and 10.3%, respectively. The $CaZrTi_2O^7$ phase exhibits anisotropic behavior in which the expansion of the monoclinic cell in the c-direction is over five times that of the a-direction. Despite this relatively large anisotropic expansion ratio, no microcracking was observed. Microcracking was not observed in $Gd_2Ti_2O_7$ either, and both materials maintained their physical integrity during the course of the study.

29940 Neutron scattering studies of pretransitional phenomena in structural phase transformations. Shapiro, S.M. (Brookhaven National Lab., Upton, NY). *Metallurgical Transactions, [Section] A: Physical Metallurgy and Materials Science;* **12**: 567-573(Apr 1981). Contract AC02-76CH00016.

Materials exhibiting structural phase transformations are well known to possess pretransitional phenomena. Below the transition temperature, T/sub c/, an order parameter appears and the pretransitional effects are associated with the fluctuations of the order parameter. Neutron scattering techniques have proved invaluable in studying the temporal and spatial dependence of these fluctuations. $SrTiO_3$ is the prototypical example of a structural phase transformation exhibiting features observable in other transformations such as martensitic and order-disorder. The experimental evolution of the understanding of the phase transformation in $SrTiO_3$ will be reviewed and the features observed will be shown to typify other systems.

29941 Probable leaching mechanisms for UO_2 and spent fuel. Wang, R.; Katayama, Y.B. (Pacific Northwest Lab., Richland, WA). pp 379-386 of Scientific basis for nuclear waste management. Vol. 3. Moore, J.G. (ed.). New York, NY; Plenum Publishing Corp. (1981). Contract AC06-76RL01830.

The oxidation and dissolution mechanisms for UO_2 and spent fuel will be quite similar based on this preliminary work with electrochemical leaching of UO_2 and spent fuel. In solutions containing oxygen or other oxidizing species, the UO_2 surface will be rapidly oxidized and dissolved following the transformation of uranium from U(IV) to U(VI). The hydrolysis of dissolved uranyl ions forms solid UO_3 hydrates or related complex compounds deposited onto the UO_2 surface, or other surfaces, as thin or thick coatings. Depending on the pH, temperature and time, the various kinds of porosity and the mechanical properties of the hydrate coatings will control the dissolution rate. The effects of radiation, in terms of generation of H_2O_2 will enhance the dissolution kinetics. Electrochemical methods may be useful for determining the surface conditions, dissolution rate and accelerated dissolution behavior for UO_2 and spent fuel. Electrochemical methods can rapidly generate much information in terms of dissolution rate and surface film properties such as thickness, porosity and oxidation state, in-situ during the progress of the leaching process. 5 figures.

29042 **Application of EELS to the study of metal-hydrogen systems.** Zaluzec, N.J.; Schober, T.; Westlake, D.G. (Argonne National Lab., IL). *Proceedings - Annual Meeting, Electron Microsopy Society of America;* 194-195(1981).

This is a preliminary study of metal-hydrogen systems using the technique of electron energy loss spectroscopy (EELS) in an analytical electron microscopy (AEM). The study of hydrogen in rare earth metals using EELS was first reported in 1976; plasmon scattering was measured in various metal and hydride phases in that study as well as in this study. Hydrogenated specimens of Zr, Ti, Mg, V and FeTi containing second phase regions of the hydrides: δ-$ZrH_{1.6}$, TiH_2, MgH_2, B-VH_2 and both B-FeTiH and γ-$FeTiH_2$ were studied using a Philips EM400 AEM fitted with a $\pi/2$ magnetic sector. Experimental data was included showing the effects of the formation of the hydride phase on the EEL spectra in Zr, Ti, and Mg. Energy shifts of $\sim$ 1.5, $\sim$ 2.8 and $\sim$ 4.2 eV were measured for Zr, Ti, and Mg respectively, while no detectable shift was found for the V and FeTi systems. The hydride phase of Mg is an insulator. The formation of hydride phases in the Zr system markedly affects the electronic properties, while in the V system electrical resistivity measurements show no change between the metal and hydride phases. This correlates well with the energy peaks suggests the density of loosely bound electrons is not significantly affected by the presence of hydrogen. 1 figure, 1 table. (DP)

29043 **Spontaneous fragmentation of an alpha-active ceramic: a mechanism for dispersion of solid waste.** Clinard, F.W. Jr.; Rohr, D.L. (Los Alamos Scientific Lab., NM). pp 405-412 of Scientific basis for nuclear waste management. Volume 3. Moore, J.G. (ed.). New York, NY; Plenum Publishing Corporation (1981).

Results reported here show that: spontaneous fragmentation of $^{238}PuO_2$ generates a wide range of particle sizes, from a few mm to 1000 A or less; the phenomenon may continue with time or may saturate, depending on starting material; and the magnitude of the effect is dependent on storage environment. Neither thermal stresses nor lattice damage appear to be solely responsible for fragmentation, but radiolysis of the environment could play an important role. Work is continuing in an effort to identify the controlling factors in this phenomenon. 4 figures.

29044 **Cubic zirconia, the latest diamond imitation and skull melting.** Nassau, K. San Diego, CA; Lapidary Journal, Inc. (1977). 7p.

To be a convincing diamond imitation, a substitute must have a high refractive index to provide brilliance, a high dispersion to provide fire, be essentially colorless, and it must also be hard enough to stand up to the usual hazards of wear. Over the years there have been many synthetics which were used as imitations of diamond and have met these criteria to varying extent. Following the early use of rutile (yellowish and soft), strontium titanate (soft and just too fiery), colorless pinel and sapphire (hard but not brilliant enought), the more recent synthetic garnet-structured YAG and GGG have provided fairly convincing diamond substitutes. A recent newcomer to this list is cubic zirconia, ZrO_2. Cubic zirconia is the cubic modification of monoclinic baddeleyite which has also been observed occurring in nature but was never given a mineral name. With a refractive index of 2.15 to 2.18, dispersion of 0.060 to 0.063 and hardness 7 1/2 to 8 1/2 (these figures are provisional, see below) cubic zirconia yields faceted gemstones which appear to be much more convincing than any of the other diamond imitations and pose a definite identification problem to the unwary. No less than three companies in the USA, Switzerland, and Russia are now producing crystals of cubic zirconia. All three manufacturers use the crystal growth technique of skull melting, a recent technique which avoids the use of a crucible by a specially shaped radio frequency apparatus and employs solidification of a melt by slow cooling.

3603 Composite Materials

REFER ALSO TO CITATION(S) 29480

29045 **Method for fabricating thin films of pyrolytic carbon.** Brassell, G.W.; Lewis, J.J.; Weber, G.W. (to Dept. of Energy). US Patent 4,332,751. 1 Jun 1982. Filed date 13 Mar 1980. vp.

PAT-APPL-129868.

The present invention relates to a method for fabricating ultrathin films of pyrolytic carbon. Pyrolytic carbon is vapor deposited onto a concave surface of a heated substrate to a total uniform thickness in the range of about 0.1 to 1.0 micrometer. The carbon film on the substrate is provided with a layer of adherent polymeric resin. The resulting composite film of pyrolytic carbon and polymeric resin is then easily separated from the substrate by shrinking the polymeric resin coating with thermally induced forces.

29046 **Method for preparing surfaces of metal composites having a brittle phase for plating.** Coates, C.W.; Wilson, T.J. US Patent Application 6-379,799. 19 May 1982. 8p. Contract W-7405-ENG-26.

The present invention is directed to a method for preparing surfaces of two-phase metal composites having relatively brittle and malleable components for plating with corrosion-resistant material. In practice of the present invention, the surfaces of the composite are etched to remove a major portion or fraction of the brittle component. The etched surface is then peened with particulates for breaking the brittle component from the surfaces and for spreading or smearing the malleable component over the surfaces. The peened surface is then chemically cleaned of residual traces of the brittle component to which the corrosion-resistant material may be plated thereon in an adherent manner.

29047 **Thermomechanical characterization of graphite/polyimide composites.** Kunz, S.C. (Sandia Natl Lab, Albuquerque, NM, USA). *American Society for Testing and Materials, Special Technical Publication;* 33-53(1982). (CONF-8011179—).

From ASTM conference on design of fatigue and fracture resistant structures; Bal Harbour, FL, USA (10 Nov 1980).

The stiffness, strength, and shear properties of three polyimide resins combined with three different moduli graphite have been determined in the temperature range 20 to 371/degree/C(68to700/degree/F). Flexural test results from the various unidirectional composites show that stiffness retention with increasing temperature is affected only by the thermal integrity of the polyimide matrix. Thermal-oxidative stability of the various graphite fibers, and its effect on interfacial strength degradation, are considered primary causes for the fiber-type dominated strength behavior. In general, strength retention appears directly related to degree of graphitization (modulus) of the fibers. The accumulated mechanical property data, some previously unknown, are correlated with microstructural features such as fiber-matrix adhesion, porosity, and processing defects.

3604 Polymers And Plastics

REFER ALSO TO CITATION(S) 28839, 28839, 29026, 29043, 29044, 29795, 30146

29948 **(CONF-830303—15) Small-angle neutron scattering from polystyrene-DVB networks containing a delta fraction of deuterated polystyrene: evidence for aggregation during polymerization.** Fernandez, A.M.; Widmaier, J.M.; Wignall, G.D.; Sperling, L.H. (Lehigh Univ., Bethlehem, PA (USA). Materials Research Center; Oak Ridge National Lab., TN (USA); Strasbourg-1 Univ., 67 (France)). 1983. 6p. NTIS, PC A02/MF A01. Order Number DE83009772.

From 185. American Chemical Society national meeting; Seattle, WA, USA (20 Mar 1983).

Sample No. 1 yielded a mol wt of 70,000 g/mole and a Z-average radius of gyration of 121 A. The delta fraction of polystyrene of interest has a mol wt of 50,000-72,000 g/mole, depending on position, and suggestive of aggregation. Some speculation is made on the aggregation mechanism. (DLC)

29949 **(SAND—82-2674) Replication of architectural antiquities using polymeric materials.** Frye, E.R. (Sandia National Labs., Albuquerque, NM (USA)). Mar 1983. Contract AC04-76DP00789. 16p. NTIS, PC A02/MF A01. Order Number DE83010216.

In support of the University of New Mexico's Maxwell Museum of Anthropology, a number of volunteers undertook the replication of Chaco Canyon masonry. Composite rubber latex and glass fabric molds were developed and a series of molds fabricated directly on the Chaco structures. From these, a set of fiberglass epoxy models was constructed depicting about 200 ft^2 of various masonry styles, and doorway and kiva niche features.

29950 **Viscosity enhancement by molecular association complexes.** Prud'homme, R.K. (Princeton Univ., NJ). *Society of Petroleum Engineers of A.I.M.E. (American Institute of Mining, Metallurgical and Petroleum Engineers), Paper;* 9-15(1982). (CONF-820419—).

Associations between polyethylene oxide polymer (PEO) chains and species containing sulfate groups can be used to increase the viscosity and elasticity of the polymer solutions. The condensation of sodium dodecyl sulfate (SDS) micelles onto the PEO chain is shown to lead first ot chain coil collapse and then to network or gel structure formation as SDS concentration is increased. Stronger interactions are produced between PEO and either Congo-red dye (a large organic molecule with two widely spaced sulfate groups) or polystyrene sulfonate. In these cases the association complexes lead to minor changes in the solution viscosity, but large changes in the primary normal stress and storage modulus G' at low frequencies. The structures formed by association are disrupted by flow but rapidly reform. Association complexes are an attractive way of obtaining high viscosity fluids that are resistant to permanent shear degradation.

29951 **Phase behavior of simple salt tolerant sulfonates.** Barakat, Y.; Fortney, L.N.; Lalanne-Cassou, C.; Schechter, R.S.; Wade, W.H.; Yiv, S.H. *Society of Petroleum Engineers of A.I.M.E. (American Institute of Mining, Metallurgical and Petroleum Engineers), Paper;* 77-97(1982). (CONF-820419—).

Alkane and α-olefin sulfonates can be utilized to produce optimal microemulsion formulations which have very high salinity (including divalent ion) tolerance while maintaining large solubilization parameters and low interfacial tensions. Such molecules require elevated temperatures or higher alcohol concentrations to suppress liquid crystal formation. As found for other species, solubilization is inversely related to width of the three phase regime, and interfacial tension and solubilization are strongly coupled.

29952 **Measurements of single chain form factors by small-angle neutron scattering from polystyrene blends containing high concentrations of labelled molecules.** Wignall, G.D. (Oak Ridge National Lab., TN); Hendricks, R.W.; Koehler, W.C.; Lin, J.S.; Wai, M.P.; Thomas, E.L.; Stein, R.S. *Polymer;* **22**: 886-889(Jul 1981). Contract W-7405-ENG-26.

A series of small angle neutron scattering measurements on blends of normal polystyrene (PSH) and labelled (deuterated) polystyrene (PSD) have been made with concentrations of PSD from 5 to 50 mol %. It is shown that the single chain form factor of the polymer in bulk can be obtained from a single concentration measurement for any concentration of labelled molecules, providing the molecular weights of the parent and labelled molecules are the same and the molecular weight distributions are narrow.

3606 Other Materials

REFER ALSO TO CITATION(S) 28837, 28840, 28842, 28843, 28844, 28845, 28846, 28847, 28848, 28849, 28850, 28851, 28852, 28853, 28854, 28855, 28856, 28858, 28859, 28860, 28861, 28862, 29181, 29220, 29221, 29222, 29223, 29224, 29225, 29226, 29227, 29228, 29229, 29230, 29231, 29232, 29233, 29234, 29234, 29235, 29236, 29237, 29238, 29244, 29305, 29306, 29307, 29333, 29571, 29573, 29583, 29671, 29717, 29901, 29994, 30102, 30646, 30654, 30660, 30812

29953 **(CONF-830336—1) Recent developments in graphite.** Cunningham, J.E. (Oak Ridge National Lab., TN (USA)). 1983. Contract W-7405-ENG-26. 4p. NTIS, PC A02/MF A01. Order Number DE83009783.

From American Society for Metals meeting; Cleveland, OH, USA (16 Mar 1983).

Overall, the HTGR graphite situation is in excellent shape. In both of the critical requirements, fuel blocks and support structures, adequate graphites are at hand and improved grades are sufficiently far along in truncation. In the aerospace field, GraphNOL N3M permits vehicle performance with confidence in trajectories unobtainable with any other existing material. For fusion energy applications, no other graphite can simultaneously withstand both extreme thermal shock and neutron damage. Hence, the material promises to create new markets as well as to offer a better candidate material for existing applications.

29954 **(LAFI—027) Recombination of radiation defects in alkali halide crystals at low temperature.** Aboltin, D.E.; Zirap, V.E. (AN Latvijskoj SSR, Riga. Inst. Fiziki). 1981. 23p. (CONF-810573—11). NTIS (US Sales Only), PC A02/MF A01. Order Number DE83701507.

From International conference on defects in insulating crystals; Riga-Salaspils, USSR (18 May 1981).

The complex investigation of the ionic-electronic processes of the charge transport and thermally stimulated luminescence of colour centres (I, α, F, F', Vsub(K) and H) in X-irradiated KBr, NaCl, NaI and KCl crystals at 4.2 K has been carried out. The experiment has been performed on X-irradiated KBr at 4.2 K by a complex of thermally stimulated methods. A number of substages of temperature annealing of different defects was studied. The effect of electron tunneling "recharge" in the excited defect pair (F-H) during photostimulation in the F-band of KBr is observed which results in the charged Frenkel defect pair formation (α-I). The conclusion is drawn that the tunneling "recharge" of the non-excited F-H pair is unlikely. It was observed that the Frenkel defect (I, α, "H-Vsub(K)", F, H') accumulation efficiencies increases by 10% or more if the X-irradiation at 4.6 K is carried out under an applied DC field of 3 kV/cm. Two competitive mechanism of the primary generation of the anion Frenkel defects are discussed. The formation of the self-trapped excitons and their luminescence as a result of the H and F centers direct recombination could be noneffective. It is found that anion exciton dissociation into the electron- hole pair is a process competitive to the exciton decay into the Frenkel defect pair.

29955 **(LAFI—043) Temperature dependence of radiation colloidal centers production and annealing in alkali halide crystals.** Kristapson, J.Z.; Ozerskii, V.J. (AN Latvijskoj SSR, Riga. Inst. Fiziki). 1981. 9p. (CONF-810573—9). NTIS (US Sales Only), PC A02/MF A01. Order Number DE83700206.

From International conference on defects in insulating crystals; Riga-Salaspils, USSR (18 May 1981).

The investigation results on temperature dependences of production and annealing of radiation colloidal color centers have been reviewed. In order to produce such centers in NaCl, KCl and KBr crystals the doses of 10^2-10^4 Mrad as well as irradiation temperatures of 300-600 K and post-irradiation heating of up to 800 K were applied. It has been demonstrated that to produce X-centers, it is

necessary to have optimal temperature and initial critical dose during both irradiation and post-irradiation heating of crystals. It has been also found that during annealing hole centers produced are different with regard to thermal stability. The possible recombination mechanisms of hole and electron products of radiolysis during post-irradiation heating has been analyzed.

29956 **(LYCEN—8161) Study of gold diffusion in thin-film glass semiconductor $GeTe_4$ by nuclear methods.** Bendali, M. (Lyon-1 Univ., 69 - Villeurbanne (France). Inst. de Physique Nucleaire; Lyon-1 Univ., 69 (France)). 1981. 90p. (In French). NTIS (US Sales Only), PC A05/MF A01. Order Number DE83700207.

Thesis.

Recent considerable interest has been brought to amorphous S.C. Their study can lead to a greater understanding of the non-crystalline state as well as of crystallization mechanisms. Gold thin-film-diffusion profiles into the A.S.C. $Ge_{18}Te_{82}$ has been studied versus different annealing conditions using nuclear backscattering analysis. Atomic diffusion into the amorphous film has been showed to be tightly related to the diffusion into polycrystalline configurations, and classical polycrystalline models have been successfully employed in the amorphous case. Moreover, the comparison between air and vacuum annealing has emphasized the delaying action of oxygen. This element, adsorbed mainly on Ge and Te sites, leads to oxide formation that can even inhibit the nucleation and growth processes of the crystalline compound AuTesub(1,7).

29957 **(ORNL/TM—8579/S1) Leach and radiolysis data for FUETAP concretes containing SRP wastes.** Dole, L.R.; Rogers, G.C.; Morgan, M.T.; Stinton, D.P.; Kessler, J.H.; Robinson, S.M.; Moore, J.G. (Oak Ridge National Lab., TN (USA)). Apr 1983. Contract W-7405-ENG-26. 270p. NTIS, PC A12/MF A01. Order Number DE83010789.

Portions are illegible in microfiche products.

This supplement to ORNL/TM-8579 contains experimental results for leach tests and alpha-radiolysis tests made on FUETAP concretes containing Savannah River Plant waste. The results, presented in two sections, consist of both the raw data and calculated values for individual experiments. This information is summarized and analyzed in Sections 5 and 7 of ORNL/TM-8579.

29958 **(SAND—82-2796C) Proposed origin of the 1.4-eV luminescence in donor-doped CdTe.** Norris, C.B. (Sandia National Labs., Albuquerque, NM (USA)). 1983. Contract AC04-76DP00789. 10p. (CONF-830345—1). NTIS, PC A02/MF A01. Order Number DE83008906.

From American Physical Society meeting; Los Angeles, CA, USA (21 Mar 1983).

Portions are illegible in microfiche products.

Prior attributions of the 1.4-eV luminescence in CdTe to V/sub Cd/-Donor complexes are consistent with some data but conflict with heat treatent results from CdTe:In which indicate that V/sub Cd/ are not involved. This paper reports new heat-treatent experiments on CdTe:Cl and compares the results to previous work on CdTe:In. Evidence for the release of alkali as the 1.4-eV luminescence is weakened is an important clue to the defect reactions occurring during heat treatment as well as to the origin of the 1.4-eV band. It is proposed that the 1.4-eV luminescence results from transitions in A/sub Cd/-Donor complexes, where A is an alkali. This proposal is consistent with the known features of the 1.4-eV luminescence and connects with the V/sub Cd/-Donor hypothesis in that the latter centers are the high-temperature precursors to the 300K-stable A/sub Cd/-Donor centers.

29959 **(SAND—83-0825C) Crystallization and morphology changes in tantalum di-silicide: a transmission-electron-microscope study.** Sharp, D.J.; Panitz, J.K.G.; Hills, C.R. (Sandia National Labs., Albuquerque, NM (USA)). 1983. Contract AC04-76DP00789. 6p. (CONF-830431—1). NTIS, PC A02/MF A01. Order Number DE83009936.

From American Vacuum Society meeting; Albuquerque, NM, USA (25 Apr 1983).

The early stages of crystallization and grain growth of tantalum di-silicide in sputter deposited single phase amorphous films were studied using transmission-electron microscopy. A calibrated hot stage was used to enable direct observation to be made at temperatures from 350 to 950°C. Sharpening of the original diffuse amorphous diffraction patterns indicated that crystallization began after approximately 40 minutes at 350°C. Heating to slightly higher temperatures (375 to 400°C) resulted in fully developed diffraction patterns corresponding to crystalline tantalum di-silicide. At higher temperatures, 850 to 950°C, grain growth and indications of significant volume reduction were observed.

29960 **Temperature dependence of the hyperfine parameters of anomalous muonium in germanium.** Blazey, K.W. (IBM Zurich Research Lab., Rueschlikon, Switzerland); Estle, T.L.; Holzschuh, E.; Odermatt, W.; Patterson, B.D. *Muon SR Newsletter;* No. 28, 1367-1385(24 Dec 1982).

The anomalous-muonium hyperfine interaction in germanium has been assured as a function of temperature between 5 and 100°K. It was found that the component perpendicular to the defect axis decreases, while the component parallel to the axis increases as the temperature increases. Both effects are a result of the interaction of anomalous muonium with the germanium-host phonons. The temperature dependence of the anomalous muonium hyperfine interaction in diamond, silicon and germanium are compared.

29961 **Muonium atoms observed in neopentane and tetramethylsilane.** Miyake, Y. (Univ. of Tokyo, Japan); Tabata, Y.; Nishiyama, K.; Nagamine, K. *Muon SR Newsletter;* No. 28, 1407-1421(24 Dec 1982).

Muonium has been observed in neopentane and tetramethylsilane by a pulsed MuSR method. The probability of muonium formation was about 20%, and its relaxation times were 8 and 2.6 μs for liquid neopentane and tetramethylsilane, respectively. The rate of muonium relaxation has been shown to be correlated well with the dissociation energy of the C-H bonding.

29962 **Screening of impurities in semiconductors: muonium in germanium, silicon and diamond.** Manninen, M. (Swiss Inst. for Nuclear Research, Villigen, Switzerland); Meier, P.F. *Muon SR Newsletter;* No. 28, 1422-1437(24 Dec 1982).

Using the density functional formalism and the pseudopotential description of the electronic structure of a semiconductor a new simple theory is derived for calculating the ground state impurity level for deep donors. The wave-function of the impurity level is determined self-consistently from a set of equations involving the dielectric self-consistently from a set of equations involving the dielectric function and the pseudopotential of the host lattice. The theory is applied to muonium in diamond, Si, and Ge and it is shown that the muon zero-point motion is essentially important in calculating the hyperfine frequency. The calculated results are in a qualitative agreement with the experiments.

29963 **Characteristics of muon states in silicon.** Boekema, C. (Los Alamos National Lab., NM). *Muon SR Newsletter;* No. 28, 1438-1450(24 Dec 1982).

Recent results of muon spin rotation studies on silicon are discussed. Special attention is paid to the temperature and doping dependence of the formation probabilities and relaxation rates of the observed muon states. It is argued that normal muonium (Mu) and anomalous muonium (Mu*) are two completely different states with respect to physical and chemical properties. Mu* is a localized state, whereas evidence suggests that Mu diffuses through the silicon lattice.

29964 **Muon spin rotation in antiferromagnetic oxides.** Boekema, C. (Los Alamos National Lab., NM); Denison, A.B.; Rueegg, K.J. *Muon SR Newsletter;* No. 28, 1451-1465(24 Dec 1982).

Muon spin rotation results for antiferromagnetic oxides with the corundum structure are discussed. An attempt to determine the muon stop sites and their chemical environment in these oxides is presented. In addition to the magnetic dipole contribution, a covalent contribution to the effective magnetic field at the muon site is considered. An interpretation of the muon hyperfine interactions in these oxides in terms of muon bond formation, analogous to the hydrogen-oxygen bonding, is given.

29965 Self-consistent field investigation of location and hyperfine interaction of muonium in diamond. Sahoo, N. (State Univ. of New York at Albany); Mishra, S.K.; Mishra, K.C.; Coker, A.; Das, T.P.; Mitra, C.K.; Snyder, L.C.; Glodeanu, A. *Muon SR Newsletter;* No. 27, 1343-1355(1 Jul 1982).

Using an unrestricted Hartree-Fock self-consistent field cluster approach, the potential experienced by a muon in diamond has been investigated. The results show conclusively that normal muonium is localized in the tetrahedral interstitial space. Using the calculated spin density and averaging it explicitly over the vibrational motion of the muon a successful explanation is obtained for the observed reduction of the hyperfine field as compared to free muonium.

29966 Glass capable of ionic conduction and method of preparation. Susman, S.; Boehm, L.; Volin, K.J.; Delbecq, C.J. US Patent Application 6-375,525. 6 May 1982. 19p. Contract W-31-109-ENG-38.

Sulfide glasses capable of conducting alkali metal ions are prepared from a nonmetal glass former such as GeS_2, B_2S_3 and SiS_2 in mixture with a glass modifier such as Na_2S or another alkali metal sulfide. A molten mixture of the constituents is rapidly quenched to below the glass transition temperature by contact with a metal mold. The rapid quench is sufficient to prevent crystallization and permit solidification as an amorphous solid mixture. An oxygen-free atmosphere is maintained over the mixture to prevent oxidation. A new glass system of (1 - X) Na_2O:XB_2S_3 is disclosed.

29967 Characterization of mechanical properties of nuclear waste glasses. Richter, H. (Frauhofer-Institut fuer Werkstoffmechanik, Freiberg, Germany); Offermann, P. pp 229-238 of Scientific basis for nuclear waste management V. Lutze, W. (ed.). New York, NY; North-Holland (1982).

From 5. international symposium on the scientific basis for radioactive waste management; Berlin, F.R. Germany (7 Jun 1982).

In order to provide data for a mechanical stability assessment of nuclear waste forms, fracture mechanics crack growth parameters, strength values, Young's modulus (between room temperature and 500°C) and the coefficient of thermal expansion (between 100 and 400°C) were measured. As far as crack growth and strength is concerned the experimental results show that loading of borosilicate glass with waste oxides does not detrimentally influence the properties of the resulting glass; glass ceramics show an even improved behavior. Young's modulus and coefficient of thermal expansion also lie in the range of data known for ordinary glasses. The results mean that the glasses investigated can be regarded to have a sufficient potential as a solidification product as far as their mechanical properties are concerned. However, in order to make a complete assessment of the mechnical stability of glassy nuclear waste forms the stress distribution in the glass form under consideration and its flaw size distribution must be analyzed as well.

29968 Fracture appraisal of large scale glass blocks under realistic thermal conditions. Laude, F.; Vernaz, E.; Saint-Gaudens, M. (CEA Valrho, Bagnols sur Ceze, France). pp 239-247 of Scientific basis for nuclear waste management V. Lutze, W. (ed.). New York, NY; North-Holland (1982).

From 5. international symposium on the scientific basis for radioactive waste management; Berlin, F.R. Germany (7 Jun 1982).

The theoretical studies show that it is possible to calculate the stresses created for different cooling histories, but it is difficult to evaluate quantitatively the state of fracture of a glass, because this depends on the presence and distribution of inclusions and faults. The experimental studies concerning large glass blocks allow order of magnitude estimates of fracturing. It is difficult to avoid such fracturing, especially during the cooling period after casting in a hot cell. Short periods of reheating may cause the physical reconstitution of the glass. The heat created by fission product decay may contribute to this process.

29969 Attempt to assess the long-term crystallization rate of nuclear waste glasses. Jacquet-Francillon, N.; Pacaud, F.; Queille, P. (CEA Valrho, Bagnols sur Ceze, France). pp 249-259 of Scientific basis for nuclear waste management V. Lutze, W. (ed.). New York, NY; North-Holland (1982).

From 5. international symposium on the scientific basis for radioactive waste management; Berlin, F.R. Germany (7 Jun 1982).

There exists an empirical Arrhenius type relationship between time and temperature at maximum crystallization for temperatures above T/sub g/; the apparent activation energy is lowered by an increase in the number of crystalline phases forming in the glass. A maximum crystallized volume fraction can be calculated by measuring the devitrification heat output either by isothermal calorimetry or by slow DSC. The volumetric devitrification heat is largely independent of the nature of the crystals formed. However, the microcalorimetric sensitivity limits this method to glasses which devitrify by more than 2 to 3% of their volume in a short time. The utilization of these empirically calculated relationships for the determination of a crystallization rate below the glass transformation temperature, T/sub g/, should be done with great caution, because at this temperature other phenomena control changes of the glass structure such as devitrification.

29970 Quantitative determination of crystalline phases in nuclear waste glasses. Feld, R.H.; Stammler, M. (Battelle-Institut e.V., Frankfurt, Germany). pp 262-271 of Scientific basis for nuclear waste management V. Lutze, W. (ed.). New York, NY; North-Holland (1982).

From 5. international symposium on the scientific basis for radioactive waste management; Berlin, F.R. Germany (7 Jun 1982).

It could be shown that it is possible to determine the weight fractions of crystalline substances dispersed in a glass matrix. The error is about 10% of the actual content for weight fractions between 4 and 10 wt %. It is about 20% for weight fractions between 1 and 4 wt % and up to 100% for weight-fractions less than 1 wt %. Stable phases like ruthenium, were in fact determined with the expected weight fractions. Chemical reactions which may occur during sintering can be followed quantitatively. This method appears to be well suited for determining the recrystallization behavior of nuclear waste glasses. We learned during the conference that a similar procedure is applied by the CEA to characterize French HLW-glasses.

29971 Effect of Fe_2O_3/ZnO on two glass compositions for solidification of Swedish nuclear wastes. Nogues, J.L. (Universite des Sciences et Techniques du Languedoc, Cedex, France); Hench, L.L. pp 273-278 of Scientific basis for nuclear waste management V. Lutze, W. (ed.). New York, NY; North-Holland (1982).

From 5. international symposium on the scientific basis for radioactive waste management; Berlin, F.R. Germany (7 Jun 1982).

Replacement of half of the ZnO in an alkali-zinc-borosilicate nuclear waste glass with Fe_2O_3 degrades leach resistance by approximately a factor of 3. Leach rates for the higher ZnO containing glass after 28 days are generally in the range of 5.10^{-5} $g.cm^{-2}.d^{-1}$ for B^{3+}, Al^{3+}, Mo^{6+}; 2.10^{-5} $g.cm^{-2}.d^{-1}$ for Na^{+}, Si^{4+}; and 2 to 7.10^{-6} $g.cm^{-2}.d^{-1}$ for Fe^{3+} and Zn^{2+}. The surface of both types of glass appears to be protected by dual protective layers, one rich in SiO_2 and a second very thin film rich in multivalent species. The second film that contains a mixture of Zn and Fe is less effective as a diffusion barrier and is less resistant to network breakdown than the film without the Fe^{3+}. This apparently is because a critical concentration of multivalence species is necessary to stabilize the second protective film. Differences in surface area to solution volume ratios affect the formation of the protective films and the rates of surface damage of the glass.

29972 Investigation on the oxidation state and the behavior of molybdenum in silicate glass. Horneber, A. (Universitaet Erlangen-Nuernberg, Germany); Camara, B.; Lutze, W. pp 279-288 of Scientific basis for nuclear waste management V. Lutze, W. (ed.). New York, NY; North-Holland (1982).

From 5. international symposium on the scientific basis for radioactive waste management; Berlin, F.R. Germany (7 Jun 1982).

This paper deals with the following: (1) Oxidation state of Mo when organic reducing agents, i.e., formic acid, formaldehyde, tannic acid, are added to the batch. (2) Dependence of Mo solubility on the melting atmosphere. (3) Behavior of the different oxidation states of Mo depending on the temperature and the basicity of the glass. (4) Redox interaction of Mo with Fe, Cr and Ti.

29973 **Materials balance: scientific fundamentals for the quality assurance of vitrified waste.** Schiewer, E. (Hahn-Meitner-Institut fuer Kernforschung Berlin, Germany); Rabe, H.; Weisenburger, S. pp 289-297 of Scientific basis for nuclear waste management V. Lutze, W. (ed.). New York, NY; North-Holland (1982).

From 5. international symposium on the scientific basis for radioactive waste management; Berlin, F.R. Germany (7 Jun 1982).

For a 10 day vitrificatoin experiment with simulated HLLWQ an almost complete materials balance could be achieved. The dissolution of a molybdenum protecting tube could easily be recognized in the materials balance. The corrosion product input can be calculated from the materials balance, and the corrosion rates for the corresponding materials can also be obtained. The corrosion rates for the 10 day experiment do not show any interference inthe vitrification of the LEWC. The maximum SO_3 content of the melt is $\sim$ 0.70%. Changes in the composition of the glass frit only slightly influence the solubility of SO_3 in the borosilicate glass. The saturation with SO_3 occurs as soon as the LEWC content in the glass reaches 14%. In future experiments the HLW contents should be adapted to the greatest possible SO_3 should be observed. If the solubility of the SO_3 in the glass has been exceeded, a second phase forms in the melter, which must increase in amount when the evaporation products are completely recycled, and as the duration of vitrification is extended. It cannot, therefore, be excluded that the degree of the corrosion of other individual materials will not be affected.

29974 **Effects of radiation damage and radiolysis on the leaching of vitrified waste.** Burns, W.G.; Hughes, A.E.; Marples, J.A.C.; Nelson, R.S.; Stoneham, A.M. (Atomic Energy Research Establishment, Harwell, England). pp 339-348 of Scientific basis for nuclear waste management V. Lutze, W. (ed.). New York, NY; Horth-Holland (1982).

From 5. international symposium on the scientific basis for radioactive waste management; Berlin, F.R. Germany (7 Jun 1982).

Two sets of leach testing experiments were carried out. The first was restricted to the glass composition UK189 doped with about 5 wt % ^{238}Pu. From the results it can be seen that only modest increases in leach rate have been observed even after 5.6 x 10^{18} α-decays per gram, equivalent to about 1.4 million years for vitrified Magnox waste. In the second series of experiments, samples of four glasses and a glass ceramic were doped with 2.5 wt % $^{238}PuO_2$. Only relatively small changes in leach rate were found. Studies on recovery during irradiation indicate that recovery must be taken into consideration in assessing the relevance of simulation experiments to the real situation in vitrified wastes. In the radiolysis of leachant studies, three cases were considered: (1) 2.4 Mrad/h γ-radiation; (2) 4 Mrad/h α-radiation, which is the dose to theleachant when the $^{238}PuO_2$-doped samples are leach tested. Here the water is assumed to be saturated with dissolved air; (3) radiation conditions that could occur in a repository assuming the leachant contacts the glass at all times. The conclusion was reached that, in the absence of air, radiolysis of the leachant will not have a large effect on the leach rate in a real repository.

29975 **Structural effects of radiation damage in silica based glasses.** Manara, A. (Joint Research Center, Ispra, Italy); Gibson, P.N.; Antonini, M. pp 349-346 of Scientific basis for nuclear waste management V. Lutze, W. (ed.). New York, NY; Horth-Holland (1982).

From 5. international symposium on the scientific basis for radioactive waste management; Berlin, F.R. Germany (7 Jun 1982).

The results of recent measurements of optical absorption, etching rate and transmission electron microscopy in pure silica and borosilicate glasses are reported and discussed. At dose saturation conditions, the dependence of the optical density associated with the production of single atomic defects from the mass of the impinging particle shows a marked saturation at masses $\geqq$ 20 amu. The corresponding etching rates increase by about 4 times with respect to unirradiated samples. In borosilicate glasses, the temperature dependence of the threshold dose rate of electrons to initiate the nucleation of bubbles shows a marked increase from about 300° to 600°K.

29976 **Leachability of zircon as a function of alpha dose.** Ewing, R.C. (Univ. of New Mexico, Albuquerque); Haaker, R.F.; Lutze, W. pp 389-397 of Scientific basis for nuclear waste management V. Lutze, W. (ed.). New York, NY; Horth-Holland (1982). Contract AC06-76RL01830.

From 5. international symposium on the scientific basis for radioactive waste management; Berlin, F.R. Germany (7 Jun 1982).

The variation in the leachability of naturally occurring zircons ($ZrSiO_4$) as a function of total alpha dose has been measured at 87°C. For calculated doses in the range of 10^{16} to 10^{18} alphas/gm there is an increase of one order of magnitude in the weight percent of zircon that is dissolved and an increase in the leach rate of the zircon 2.9 x 10^{-8} to 2.3 x 10^{-7} gm/cm^2 day. Totally metamict specimens (dose $\geqq$ 10^{19} alphas/gm) have leach rates as high as 1.8 x 10^{-6} gm/cm^2 day.

29977 **Isotopic fractionation of thorium and uranium upon leaching of monozite: alpha-recoil damage effects.** Eyal, Y. (Israel Inst. of Tech., Haifa). pp 399-408 of Scientific basis for nuclear waste management V. Lutze, W. (ed.). New York, NY; Horth-Holland (1982).

From 5. international symposium on the scientific basis for radioactive waste management; Berlin, F.R. Germany (7 Jun 1982).

The present investigation includes a study of the relative dissolution rates of the actinide isotopes ^{238}U, ^{234}U, ^{232}Th, ^{230}Th and ^{228}Th upon leaching of monazite in a bicarbonate-carbonate solution. A preferential dissolution of the radiogenic isotopes ^{234}U, ^{230}Th and ^{228}Th relative to their corresponding structurally incorporated isotopes ^{238}U and ^{234}U has been observed in the early stages of the dissolution process as well as in an advanced stage of the leaching process. This isotopic fractionation may be attributed to radiation damage caused by alpha-recoil atoms. The leachability of thorium in the present monazite sample is considerably reduced after heat treatment. The heat treatment has presumably caused a partial annealing of the alpha-recoil damage. Evidence for the occurrence of lattice repair is provided by powder x-ray diffraction measurements. The present experiments may indicate that alpha-recoil damage may endanger the integrity of any crystalline phase in groundwater environments. In particular, the damage may reduce the retention of nuclides formed by alpha transmutations and their decay products in teh solid phase relative to the retention of the corresponding isotopes bonded within the crystal structure. From thorium data reported [Eyal, Y. and Kaufman, A. (1982) Nuclear Technology (in press)] and in the present investigation, it may be inferred that in monozite-like phases the overall alpha-recoil damage may increase nearly in proportion to the alpha-particle dose in the time range ($\sim$ 10^5 y) which is required for the effective isolation of actinide wastes.

29978 **Investigation of titanium in metamict Nb-Ta-Ti oxides using the extended x-ray absorption fine structure technique.** Greegor, R.B. (Boeing Co., Seattle, WA); Lytle, F.W.; Ewing, R.C.; Haaker, R.F. pp 409-418 of Scientific basis for nuclear waste management V. Lutze, W. (ed.). New York, NY; Horth-Holland (1982).

From 5. international symposium on the scientific basis for radioactive waste management; Berlin, F.R. Germany (7 Jun 1982).

A preliminary investigation of metamict orthorhombic AB_2O_6 complex Nb-Ta-Ti oxides has been conducted using the EXAFS/XANES technique. This investigation has demonstrated the feasibility of the technique to study complex geologic or simulated radioactive waste samples. The element specificity of the technique has allowed a detailed structural analysis of the Ti site in complex metamict Nb-Ta-Ti oxides. Although preliminary, these results suggest that significant changes in Ti coordination number and geometry may take place during the metamictization process. This finding could have important implications for solid radioactive waste-forms.

29979 **Effects of Madelung potentials at surfaces of ZnO on photoemission spectra and work functions.** Watson, R.E.; Perlman, M.L.; Davenport, J.W. (Brookhaven National Lab., Upton, NY). *Surface Science;* **115**: 117-140(1982).

Madelung potentials have been calculated for sites in and near polar and nonpolar, primitive and reconstructed surfaces of wurtzite ZnO. Surface versus bulk potential differences result in

electron binding energy differences which should be observable in photoemission spectra even on nonpolar surfaces. In polar planes, the average site charges in the outermost ion layer are naturally reduced relative to charges in the crystal interior, and observable effects should be larger. Results for polar surfaces of singly bonded atoms are indicative of the Madelung potential effects expected for dense layers of chemisorbed species. These potentials are especially sensitive to details of charge transfer. If a crystal has uniform site charges except for the above-mentioned charge reduction on polar surfaces, there exist surface dipoles which would cause considerably greater variation in work function from one crystal face to another than that observed experimentally; this discrepancy is resolved if, in the outermost cation-anion layer, charges are further reduced in three-quarters to one-half the natural values.

29980 **Synthesis, structure, electrical conduction properties, and theory of divalent, tetravalent, and one-dimensional partially oxidized tetracyanoplatinate complexes.** Williams, J.M.; Schultz, A.J.; Underhill, A.E.; Carneiro, K. (Argonne National Lab., IL). pp 73-118 of Extended linear chain compounds. Volume 1. Miller, J.S. (ed.). New York, NY; Plenum Publishing Corporation (1982). Contract W-31-109-ENG-38.

Partially oxidized tetracyanoplatinate (POTCP) complexes containing Pt atoms in a nonintegral oxidation state exhibit highly anisotropic physical properties that are explained on a structural basis. Recent developments in the field of POTCP quasi-one-dimensional (1-D) metal complexes since the last published comprehensive review (1979) are reviewed. Structural studies of square planar tetracyanoplatinate (TCP) complexes are also reported. Latest developments in the synthesis of POTCP complexes are reviewed. Discussion of the interrelation between the chemical, structural, and physical properties of POTCP complexes is presented, and properties of 19 compounds are tabulated. 141 references. (BLM)

29981 **Short range atomic structure of non-crystalline carbon.** Mildner, D.F.R. (Univ. of Missouri, Columbia); Carpenter, J.M. *Journal of Non-Crystalline Solids;* **47**: 391-402(1982).

Neutron diffraction data show there is little tetrahedral bonding in glassy carbon, and correspond to the Stenhouse-Grout structure factor model for amorphous carbon taking the degenerate case in which the amount of tetrahedral bonding is negligible. This is in contrast to the x-ray results of Noda and Inagaki. Further analysis of the radial distribution function from the neutron diffraction data is presented. A brief summary of other x-ray diffraction measurements on a variety of amorphous carbons is given, all of which confirm the predominantly trigonal coordination. The disagreement of the earlier x-ray and electron diffraction measurements is due to the poor resolution and normalization of the data, and also perhaps the method of preparation. The amount of tetrahedral bonding present in amorphous carbon requires careful diffraction mesurements at large scattering vectors to enable better resolution of the peaks in the radial distribution function.

29982 **Vibrational frequencies via frozen phonons.** Harmon, B.N. (Kernforschungszentrum, Karlsruhe, Germany); Weber, W.; Hamann, D.R. *Journal de Physique (Paris), Supplement;* **42**: No. 12, C6.628-C6.630(Dec 1981). Contract W-7405-ENG-82.

A first principles linear combination of atomic orbitals (LCAO) method has been used to calculate the total ground state energy for crystals of Si, Nb, and Mo involving lattice distortions. From these calculations the equilibrium lattice constant, cohesive energy, and bulk modulus as well as the vibrational frequencies for selected phonons were determined.

40 CHEMISTRY

4001 Analytical And Separations Chemistry

REFER ALSO TO CITATION(S) 28836, 28871, 29055, 29055, 29056, 29056, 29073, 29092, 29104, 29105, 29113, 29114, 29127, 29173, 29956, 30034, 30052, 30058, 30061, 30061, 30072, 30077, 30310, 30361, 30575, 30576

29983 **(HASL—300-Ed.25) EML procedures manual.** Volchok, H.L.; de Planque, G. (eds.). (Department of Energy, New York (USA). Environmental Measurements Lab.). 1982. 844p. NTIS, PC A99/MF A01. Order Number DE83010805.

Portions are illegible in microfiche products. Original copy available until stock is exhausted.

This manual contains the procedures that are used currently by the Environmental Measurements Laboratory of the US Department of Energy. In addition a number of analytical methods from other laboratories have been included. These were tested for reliability at the Battelle, Pacific Northwest Laboratory under contract with the Division of Biomedical and Environmental Research of the AEC. These methods are clearly distinguished. The manual is prepared in loose leaf form to facilitate revision of the procedures and inclusion of additional procedures or data sheets. Anyone receiving the manual through EML should receive this additional material automatically. The contents are as follows: (1) general; (2) sampling; (3) field measurements; (4) general analytical chemistry; (5) chemical procedures; (6) data section; (7) specifications.

29984 **(INS-P—155) VPXRAY. Analysis of proton-induced x-ray spectra.** McCallum, G.J. (Department of Scientific and Industrial Research, Lower Hutt (New Zealand). Inst. of Nuclear Sciences). Dec 1980. 56p. NTIS (US Sales Only), PC A04/MF A01. Order Number DE83700413.

The program is designed for the analysis of x-ray spectra obtained following proton induced reactions in situations where the elements in the sample are already known and only intensities are to be determined. Up to eight spectra on one file can be processed without operator intervention, and the effects of small gain changes in the detecting system can be automatically compensated. The results of the fitting procedure can de displayed on the Tektronix 4025 as analysis proceeds.

29985 **(INS-P—156) VSEARC. Identify elements in x-ray spectra.** McCallum, G.J. (Department of Scientific and Industrial Research, Lower Hutt (New Zealand). Inst. of Nuclear Sciences). Dec 1980. 41p. NTIS (US Sales Only), PC A03/MF A01. Order Number DE83700414.

The program is designed to identify the elements in an x-ray spectrum on the basis of the energy of the peaks in the spectrum. The program lists the elements that could give rise to the observed peaks. The actual determination of intensities can be carried out using a program such as VPXRAY (INS-P--155). The x-ray spectrum together with the elements identified are displayed on a Tektronix 4025 display terminal. An option to plot this information on a Calcomp 565 plotter is also provided.

29986 (LA—9479-PR, pp 79-81) **Rapid, sensitive colorimetric microplate assay for hydroxyproline.** Halleck, M.S. Oct 1982. NTIS, PC A08/MF A01.

In Los Alamos Life Sciences Division's biomedical and environmental research programs. Progress report, January-December 1981.

Studies of the fibrogenicity of inhaled oil shale dusts require a rapid, sensitive method for measuring hydroxyproline. A microplate assay adapted from the method of Grant is described. (ACR)

29987 **(MLM—3057(OP)) Nondestructive evaluation of sampling error for plutonium assay.** Strohm, W.W.; Seiler, R.J.; Rodenburg, W.W. (Monsanto Research Corp., Miamisburg, OH (USA). Mound). 1983. Contract AC04-76DP00053. 4p. (CONF-830423—2). NTIS, PC A02/MF A01. Order Number DE83010021.

From 5. symposium on safeguards and nuclear material management; Versailles, France (19 Apr 1983).

Sampling is a significant source of error in the chemical assay of plutonium. A calorimetric watts/gram of sample (W/g) test on pre-weighed plutonium material is used routinely at Mound to demonstrate material homogeneity, hence, sample representativeness. A prior demonstration of sample representativeness can result

in fewer samples submitted for chemical analysis. Combining the W/g test with total dissolution of pre-weighed samples results in accurate plutonium assay. The strategy for applying the W/g test to nonhomogeneous materials needs to be further investigated. 4 tables.

29988 **(RHO-SA—56) Application of the inductively coupled plasma in support of the waste management program at Hanford.** Manabe, R.M.; Homi, C.S. (Rockwell International Corp., Richland, WA (USA). Rockwell Hanford Operations). 1978. Contract AC06-77RL01030. 17p. (CONF-781040—6). NTIS, PC A02/MF A01. Order Number DE83009581.

From 22. conference on analytical chemistry in energy technology; Gatlinburg, TN, USA (10 Oct 1978).

The inductively coupled plasma (ICP) has been applied to various sample matrices ranging from fresh water well samples to simulated Redox and Bismuth Phosphate sludges. Comparison of equivalence ratios between major cation species analyzed with the ICP and major anion species as determined by an ion chromatograph system of the fresh water well matrix resulted in ratios very close to unity. This is one indication of material accountability. Excellent agreement with atomic absorption analysis of complex mixtures from a $LiBO_2$ fusion of simulated Redox sludge was obtained. A new nebulizer design allowed aspiration of the fusion mixtures without nebulizer drift. The computer data acquisition system employed has greatly expanded the flexibility of the ICP system. The ICP software was Fortran based and allowed access to a mass storage disk operating system. The ICP operating system allowed multiple matrix calibrations to be stored and requested by simple commands. A wavelength plotting routine was also implemented to evaluate spectral interferences.

29989 **Justification of the approximation that shifts in nonbonding valence orbital ionization potential are eight-tenths of shifts in core binding energy.** Jolly, W.L.; Eyermann, C.J. (Lawrence Berkeley Lab, CA). *Journal of Physical Chemistry;* **86**: No. 24, 4834-4838(25 Nov 1982). Contract AC03-76SF00098.

Empirical and theoretical data are cited to support the approximation that shifts in strictly nonbonding valence orbital ionization potential are eight-tenths of corresponding shifts in core binding energy. This approximation is shown to be useful in the quantification of the bonding and anitbonding character of molecular orbitals.

29990 **Gas chromatographic shift of tritium-labeled compounds - an application of gas liquid radiochromatography.** Gordon, B.E.; Otvos, J.W.; Erwin, W.R.; Lemmon, R.M. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). *International Journal of Applied Radiation and Isotopes;* **33**: No. 9, 721-724(Sep 1982).

A small reduction in the gas-chromatographic retention times of a number of tritiated compounds compared to their unlabeled analogues has been observed. The shift appears to be proportional to the number of tritium atoms in a molecule.

29991 **Isotopic analysis of iodine using negative surface ionization.** Delmore, J.E. (Idaho National Engineering Lab., Idaho Falls (USA); Exxon Nuclear Idaho Co., Inc., Idaho Falls (USA)). *International Journal of Mass Spectrometry and Ion Physics;* **43**: No. 4, 273-281(Aug 1982).

Negative surface ionization (NSI) of iodine has been studied on a series of low work function surfaces with the intent of developing improved methods for isotopic analysis, particularly at the environmental level ($127/129 = 10^{4}$-10^{8}). The most promising method gives 1% ionization/transmission efficiency without measurable tailing from the major peak at ratios of 10^{8} and without spectral interferences. These results demonstrate the feasibility of performing environmental measurements by this method, and support the hypothesis that very large isotope ratios ($> 10^{6}$) are more easily measured with negative than with positive ions.

29992 **Determination of rare-earth isotope ratios by resonance ionization mass spectrometry.** Donohue, D.L.; Young, J.P.; Smith, D.H. (Oak Ridge National Lab., TN (USA). Analytical Chemistry Div.). *International Journal of Mass Spectrometry and Ion Physics;* **43**: No. 4, 293-307(Aug 1982).

The use of resonance ionization spectroscopy (RIS) for single-atom detection has generated widespread interest. Use of the resonance ionization effect in isotope-ratio mass spectrometry promises to overcome the problem of isobaric interference encountered for a variety of samples. The present work concerns the measurement of Nd and Sm isotope ratios in binary mixtures without any chemical separation. High selectivity is obtained, as shown by the preliminary results. Quantitative data are given to demonstrate the analytical potential of the technique.

29993 **Apparatus for irradiating a continuously flowing stream of fluid.** Speir, L.G.; Adams, E.L. US Patent Application 6-377,898. 13 May 1982. 14p. Contract W-7405-ENG-36.

An apparatus for irradiating a continuously flowing stream of fluid is disclosed. The apparatus consists of a housing having a spherical cavity and a spherical moderator containing a radiation source positioned within the spherical cavity. The spherical moderator is of lesser diameter than the spherical cavity so as to define a spherical annular volume around the moderator. The housing includes fluid intake and output conduits which open onto the spherical cavity at diametrically opposite positions. Fluid flows through the cavity around the spherical moderator and is uniformly irradiated due to the 4π radiation geometry. The irradiation source, for example a ^{252}Cf neutron source, is removable from the spherical moderator through a radial bore which extends outwardly to an opening on the outside of the housing. The radiation source may be routinely removed without interrupting the flow of fluid or breaching the containment of the fluid.

29994 **Utilization of charged particle backscattering to study the near surface region of glasses. Application to depth profiling of lanthanium, cerium, throium and uranium induced by aqueous leaching.** Trocellier, P.; Nens, B.; Engelmann, C. (CEN Saclay, France). pp 193-202 of Scientific basis for nuclear waste management V. Lutze, W. (ed.). New York, NY; North-Holland (1982).

From 5. international symposium on the scientific basis for radioactive waste management; Berlin, F.R. Germany (7 Jun 1982).

The main advantage of this analytical method which enables the first micrometer of the glass surface to be studied is its nondestructive character. The results obtained clearly show that aqueous leaching of glass samples containing either lanthanum and uranium or cerium and thorium induces accumulation of these heavy elements in the hydrated layer developed on the sample surface. The effectis apparently less pronounced for the cerium thorium glass.

29995 **Transport of alkali metal cations across liquid membranes by crown ether carboxylic acids.** Strzelbicki, J.; Bartsch, R.A. (Texas Tech Univ., Lubbock). *Journal of Membrane Science;* **10**: 35-47(1982). Contract AS05-80ER10604.

Competitive alkali metal transport from an a alkaline aqueous source phase through a chloroform phase to an acidic aqueous receiving phase facilitated by nine crown ethers with pendant carboxylic acid groups has been investigated. Transport selectivity is controlled by the size of the polyether cavity of the carrier. Increasing the lipophilicity of the carrier, while maintaining a constant polyether cavity size, enhances the total transport rate but does not affect the selectivity. There is poor agreement between the results of competitive transport and the behavior anticipated on the basis of single cation transport studies.

29996 **Kinetic and thermodynamic separation of Cu(II) and Fe(III) by liquid-liquid extraction with a β-hydroxyoxime in toluene.** Chiarizia, R.; Danesi, P.R. (Argonne National Lab., IL). *Separation Science and Technology;* **16**: No. 9, 1181-1191(1981). Contract W-31-109-ENG-38.

A quantitative study of the thermodynamic and kinetic separation of Cu(III) and Fe(III) by liquid-liquid extraction with to-

luene solutions of the oxime 2-hydroxy-5-t-octyl(acetophenone oxime) has been conducted. On the basis of the stoichiometry, equilibrium constants, rate laws and rate constants of the extraction reactions of Cu(II) and Fe(III) an equation has been derived which describes how the separation of Cu from Fe varies with the chemical composition of the system, the hydrodynamics of the extracting apparatus and the contact time between the aqueous and the organic phases. Our results show that separations which are not feasible thermodynamically are possible when the contact time between the two phases is kept much shorter than that required to reach equilibrium. 4 figures.

29997 **Background fitting for electron energy loss spectra.** Bentley, J. (Oak Ridge National Lab., TN); Lehman, G.L.; Sklad, P.S. pp 161-163 of Analytical electron microscopy. Geiss, R.H. (ed.). San Francisco, CA; San Francisco Press, Inc. (1981). Contract W-7405-ENG-26.

A modified background form that does work satisfactorily has been developed. It utilizes a polynomial fit to the logarithms of the electron intensity and energy loss values. There appears to be no problem in making the required extrapolations. Examples are included. 2 figures.

29998 **Effect of detector geometry on AEM-based x-ray microanalysis. I. Theoretical.** Zaluzec, N.J. (Argonne National Lab., IL); Maher, D.M.; Mochel, P.E. pp 25-28 of Analytical electron microscopy. Geiss, R.H. (ed.). San Francisco, CA; San Francisco Press, Inc. (1981).

The effects of Si(Li) detector elevation on the absorption correction in quantitative microanalysis in the analytical electron microscope were studied for low, intermediate, and high detector geometries. The model specimen was a thin amorphous film of V_3Si. 4 figures, 1 table.

29999 **Systems background in x-ray microanalysis.** Bentley, J. (Oak Ridge National Lab., TN). pp 54-56 of Analytical electron microscopy. Geiss, R.H. (ed.). San Francisco, CA; San Francisco Press, Inc. (1981). Contract W-7405-ENG-26.

Systems background (fluorescence produced at apertures in the probe-forming system and fluorescence originating near the region of the specimen) encountered in the x-ray microanalysis in the analytical electron microscope is discussed. 2 figures.

30000 **Automation of a mass spectrometer for nitrogen isotope analysis.** McInteer, B.B.; Montoya, J.G. (Los Alamos Scientific Lab., NM). pp 343-349 of Recent developments in mass spectrometry in biochemistry, medicine, and enviornmental research, 7. Frigerio, A. (ed.). Amsterdam, Netherlands; Elsevier Scientific Publishing Co. (1981).

An automated mass spectrometer is described that is able to analyze the isotopic content of several hundred samples of labeled ammonium salts per day unattended. A graphic plotter which has been modified to move a tray of up to 137 samples of dried ammonium sulfate positioned beneath a stationary head which performs the reaction procedure has been added to the mass spectrometer. The equipment has been used to run samples from labeled agricultural fertilizer samples using nitrogen compounds enriched or depleted in ^{15}N, for experiments in animal nutrition and animal waste disposal, and for biology experiments in plant physiology and forestry. In the range of 0 to 1% ^{15}N, duplicate samples agree to 0.001%. Higher enrichments are consistent with accuracy of ratio measurements. The equipment analyzes a sample in about 2 to 2.5 min. (BLM)

30001 **Dielectric constant detector for the determination of tri-n-butylphosphate in mixtures with hydrocarbons.** Klatt, L.N. (Oak Ridge National Lab., TN). *Analytica Chimica Acta;* **116**: 289-296(1980). Contract W-7405-ENG-26.

An instrument based on the measurement of dielectric constant is described for determining the tri-n-butylphosphate (TBP) content of TBP-n-dodecane solutions. The system utilizes a phase-locked-loop feedback network to measure the resonant frequency of a parallel inductor-capacitor circuit in which the sample is the dielectric material of the capacitor. The shape of the frequency vs. volume percent TBP response curve is explained by the dimerization of TBP. Values of 3.09 and 8.23 for the dielectric constant of TBP monomer and TBP dimer, respectively, were calculated. Standard mixtures containing 4 to 30% (v/v) TBP were analyzed and an average error of -0.08% TBP was obtained; average precision is 0.02% TBP. Total time required to process a sample, including chemical pretreatment, is approximately 5 min.

4002 Inorganic And Physical Chemistry

REFER ALSO TO CITATION(S) 28792, 28793, 29104, 29287, 29288, 29944, 29989, 29998, 30040, 30041, 30054, 30056, 30069, 30071, 30655, 30811

30002 **(ANL-HEP-CP—82-37) Dynamic polarization in some high-hydrogen glasses.** Hill, D.; Krumpolc, M. (Argonne National Lab., IL (USA); Illinois Univ., Chicago (USA)). 1982. Contract W-31-109-ENG-38. 7p. (CONF-8209124—1). NTIS, PC A02/MF A01. Order Number DE83009079.

From Workshop on polarized targets and materials; Upton, NY, USA (16 Sep 1982).

Research has been done in a search for hydrogen-rich glasses suitable for forming solid solutions of Cr(V) complexes, with emphasis on glasses based on amines and ammonia. The prospect for hydrogen fractions much in excess of 15 wt % seemed rather dim, but this document reports the existence of two large families of such glasses obtainable with either borane-amine complexes or ammonium borohydride as vitrifying additives. The glasses have hydrogen contents ranging up to at least 21 wt %. Moreover, at least some members of these families yield sizeable dynamic nuclear polarizations when doped with sodium bis[2-ethyl-2-hydroxybutyrato(2-)]oxochromate(V) monohydrate, [EHBA-Cr(V)]

30003 **Electronic states of the quadruply bonded $Re_2Cl_8^{2-}$ species: an ab initio theoretical study.** Hay, P.J. (Los Alamos National Lab., NM). *Journal of the American Chemical Society;* **104**: No. 25, 7007-7017(15 Dec 1982).

The electronic structure of the "quadruply bonded" $Re_2Cl_8^{2-}$ species has been studied by using ab initio wave functions and relativistic effective core potentials. The metal-metal bonding in the ground state is discussed, and the rich spectrum of electronic states below 6 eV (50,000 cm^{-1}) is treated in detail, including correlation effects and spin-orbit coupling. Highly correlated multiconfiguration wave functions are needed to describe the electrons in the weak δ bond, particularly in the ground ^1A/sub 1g/ state and the excited ^1A/sub 2u/ (calculated 2.8 eV, experimental 1.8 eV), ^3A/sub 2u/ (calculated 0.4 eV), and 2 ^1A/sub 1g/ (calculated 3.2 eV) states. These excited states involving δ-δ^* excitations all undergo torsional distortions to D/sub 4d/ geometries. The nature and relative intensities of weaker transitions involving excitations among the ten 5d orbitals as well as the strong transitions involving the Cl 3p-Re 5d charge-transfer excitations are also discussed.

30004 **Self-ionization of water at high temperature and the thermodynamic properties of the ions.** Pitzer, K.S. (Univ. of California, Berkeley). *Journal of Physical Chemistry;* **86**: No. 24, 4704-4708(25 Nov 1982). Contract AC03-76SF00098.

It is shown that gas-phase data on hydrated H^+ and OH^- ions from mass spectrometry can be used to calculate the ionization product for water at high temperature and at high enough pressure to allow relating these results with those directly measured near 1000 K and 0.5 g cm^{-3}. The thermodynamic properties of the hydrated H^+ and OH^- are discussed and the heat capacity is compared with results calculated from the Born equation for an appropriate region of temperature and pressure.

30005 **Neutron profile refinement of the structures of Li_2SnO_3 and Li_2ZrO_3.** Hodeau, J.L. (Laboratoire de Cristallographie, France); Marezio, M.; Santoro, A.; Roth, R.S. *Journal of Solid State Chemistry;* **45**: No. 2, 170-179(15 Nov 1982).

The crystal structures of the compounds Li_2SnO_3 and Li_2ZrO_3 have been refined with the Reitveld method [H. M. Rietveld, J. Appl. Crystallogr. 2, 65 (1969)] using neutron powder diffraction data collected at room temperature. Both compounds cry-

stallize with the symmetry of space group C2/c. For Li_2SnO_3, Z = 8, and the lattice parameters obtained from the refinement are a = 5.2889(2), b = 9.1872(3), c = 10.0260(3) angstrom, and β = 100.348(2)°. For Li_2ZrO_3, Z = 4, and a = 5.4218(2), b = 9.0216(4), c = 5.4187(2) angstrom, and β = 112.709(2)°. Both compounds have NaCl-type structures in which the oxygen anions, as well as the cations, form a distorted cubic close-packed network. The order among the lithium and the tetravalent cations is different in the two compounds. In Li_2SnO_3, there are two types of layers perpendicular to c*, one with Li^+ only and one with Li^+ and Sn^{4+} in the ratio 1:2. In Li_2ZrO_3, the layers perpendicular to c* are all the same with Li^+ and Zr^{4+} ions in the ratio 2:1. The different arrangement of the cations in the two structures can be explained in terms of the difference in size of Sn^{4+} and Zr^{4+}.

30006 **New EXAFS models for the iron sites of the iron molybdenum cofactor of nitrogenase: the $[(p\text{-}CH_3C_6H_4S)_2FeS_2FeS_2MoS_2]^{3-}$ trianion and the $[C_6H_5O)_2FeS_2MoS_2]^{2-}$ dianion.** Teo, B.K. (Bell Lab., Murray Hill, NJ); Antonio, M.R.; Tieckelmann, R.H.; Silvis, H.C.; Averill, B.A. *Journal of the American Chemical Society;* **104**: No. 22, 6126-6129(3 Nov 1982).

This report examines the single-crystal X-ray diffraction structure determinations and Fe EXAFS spectra of a linear trinuclear cluster anion, $[(p\text{-}CH_3C_6H_4S)_2FeS_2FeS_2MoS_2]^{3-}$ (1), and a binuclear cluster anion, $[(C_6H_5O)_2FeS_2MoS_2]^{2-}$ (2). It is noted that (1) is the first structurally characterized Mo-Fe-S cluster to contain iron in two distinct sites with localized oxidation states, whereas (2) is the first structurally characterized Mo-Fe-S cluster with terminal oxygen ligation to iron. The structures of $(Et_4N)_3[pCH_3C_6H_4S)_2FeS_2FeS_2MoS_2]$ (3) and $(Et_4N)_2[(C_6H_5O)_2FeS_2MoS_2]$ (4) were solved by conventional Patterson and Fourier techniques. In (3), two out of three Et_4N^+ cations are disordered. Refinement by full-matrix least-squares methods gave rise to a conventional R value of 8.10%, with anisotropic isotropic thermal parameters for the trianion and ordered cation and isotropic thermal parameters for all other atoms. Least-squares refinement of (4) resulted in an R value of 14.35%, with anisotropic thermal parameters for Mo, Fe, S1, and S2 and isotropic thermal parameters for all other atoms. The pseudo mirror plane at y=1/8 relating the two halves of the molecule (with Mo, Fe, S1, and S2 residing on the plane) causes severe parameter correlation, thereby preventing further anisotropic refinement. Somewhat specialized refinement procedures must be used to fully refine the structure (in progress).

30007 **Interaction of CO, CO_2, and D_2 with rhodium oxide: its reduction and catalytic stability.** Watson, P.R.; Somorjai, G.A. (Univ. of California, Berkeley). *Journal of Physical Chemistry;* **86**: No. 20, 3993-3996(30 Sep 1982). Contract W-7405-ENG-48.

This report investigated the adsorption and interaction of CO, CO_2, and D_2 with $Rh_2O_3.5H_2O$ by thermal desorption spectroscopy (TDS). Both CO and D_2 react strongly with the oxide lattice inducing decomposition during the desorption process to yield CO_2 and D_2O. Adsorbed CO_2 desorbs essentially intact. These results are compared with those found on rhodium metal formed by reducing the oxide to the metallic state. On this metallic surface CO_2 dissociates while CO and D_2 desorb without significant reaction. The use of CO_2 to maintain an oxidized metal surface in a reducing atmosphere during a catalytic reaction is discussed.

30008 **The bond length of Cr_2.** Michalopoulos, D.L.; Geusic, M.E.; Hansen, S.G.; Powers, D.E.; Smalley, R.E. (Rice Univ., Houston, TX). *Journal of Physical Chemistry;* **86**: No. 20, 3914-3916(30 Sep 1982).

Chromium clusters were prepared in a supersonic molecular beam by using a pulsed laser vaporization source. Resonant two-photon ionization (R2PI) spectroscopic scans were made with mass-selective detection for the chromium dimer. A single rovibronic band was found near 4600 angstrom and rotationally resolved for the $^{50}Cr^{52}Cr$, $^{52}Cr_2$, and $^{52}Cr^{54}Cr$ isotopic species. The band was assigned as the A $^1\Sigma$/sub u/$^+ \leftarrow X^1\Sigma^+$ O-O transition of Cr_2. Measurement of rotational constants confirmed earlier work of Efremov et al. where the same band system was observed upon flash photolysis of $Cr(CO)_6$. Rotational analysis concludes unequivocally that the bond length (rΞ) in the v = O level of the $^1\Sigma$/sub g/$^+$ ground state of $^{52}Cr_2$ is 1.68 +/- 0.01 angstrom.

30009 **Direct determination of ionic solvation from neutron diffraction.** Narten, A.H.; Hahn, R.L. (Oak Ridge National Lab., TN). *Science (Washington, D.C.);* **217**: 1249-1250(24 Sep 1982). Contract W-7405-ENG-26.

Much information on ionic solvation in electrolyte solutions has been inferred from macroscopic thermodynamic and transport properties and from spectroscopy. These ion-water interactions can now be probed directly and unambiguously by neutron diffraction. Such measurements have been done with neodymium trichloride solutions in heavy water that are identical in every respect except the isotopic state of the neodymium ions; these experiments yield in a straightforward manner the distribution of oxygen and deuterium atoms from the water molecules in the first hydration sphere of the neodymium ion. Each ion is surrounded by 8.6 oxygen atoms at a distance of 2.48 angstroms and 16.7 deuterium atoms at 3.13 angstroms indicating a well-defined first hydration sphere of water molecules, the deuterium atoms pointing away from the cation.

30010 **Rhenium: an ammonia synthesis catalyst.** Spencer, N.D.; Somorjal, G.A. (Univ. of California, Berkeley). *Journal of Physical Chemistry;* **86**: No. 18, 3493-3494(2 Sep 1982). Contract AC03-76SF00098.

Polycrystalline rhenium has been studied as a catalyst for the synthesis of ammonia from its elements. It appears to have an initial activity which is nearly an order of magnitude greater than that of the most active crystal plane of iron (Fe(111)) at the reactant pressures (20 atm) and temperatures (603 to 713 K) studied. It displays an activation energy for ammonia synthesis of 16.2 kcal mol^{-1}, which is appreciably lower than that of iron(III) (19.4 kcal mol^{-1}) under identical experimental conditions. Rhenium appears to become reversibly poisoned by the presence of 1 to 2 torr of product (ammonia), although exposure to water or presulfidation appears to have little effect on the catalytic activity (in marked contrast to the behavior of iron under similar conditions). 2 figures.

30011 **Temperature-reversible equilibria and exchange among trapping sites for SOF_2 isolated in noble gas matrices.** Swanson, B.I.; Jones, L.H.; Foltyn, E.M.; Asprey, L.B. (Los Alamos National Lab., NM). *Journal of Physical Chemistry;* **86**: No. 18, 3522-3527(2 Sep 1982).

High-resolution IR studies have been made for thionyl fluoride isolated in argon, krypton, and xenon matrices in order to probe matrix-molecule interactions and dynamics. Argon matrices show surprisingly complex site structure with at least five distinct monomer sites, whereas krypton and xenon matrices show two and three dominant trapping sites, respectively. The additional sites observed in argon are attributed to three-atom substitutional cages which are unstable in krypton and xenon matrices. The relative intensities of the various monomer sites in krypton and especially xenon change dramatically and reversibly with temperature, indicating that the inequivalent sites are in equilibrium. In addition, the frequency positions for the various sites merge and the lines broaden as temperature is raised to give single symmetric lines in the high-temperature limit. We attribute the collapse of the site structure at elevated temperatures to a facile exchange among inequivalent sites. 8 figures, 1 table.

30012 **Electronic structure of Rydberg states of H_3, NeH, H_2F, H_3O, NH_4, and CH_5 molecules.** Raynor, S.; Herschbach, D.R. (Harvard Univ., Cambridge, MA). *Journal of Physical Chemistry;* **86**: No. 18, 3592-3598(2 Sep 1982). Contract AC02-80ER10740.

Six exemplary molecules are treated for which the ground electronic state is dissociative whereas the corresponding cation is quite stable. Such molecules possess long-lived excited Rydberg states with a quasi-hydrogenic electron orbiting outside the cationic core. Electronic energies and spectroscopic transition moments are calculated by ab initio methods employing a floating spherical Slater orbital (FSSO) variational function. For H_3, the results agree satisfactorily with other calculations. For the five second-row hydride molecules, strong transitions are predicted to occur in two regions: 5000 to 7000 A and 9000 to 12,000 A. Comparison of our results for H_3 and NH_4 with the experimental spectra of Herzberg shows excellent agreement for some transitions, but large discrepan-

cies in wavelength and especially in intensities appear for other transitions. 5 figures, 6 tables.

30013 Temperature-dependent ultraviolet absorption spectrum for dinitrogen pentoxide. Yao, F.; Wilson, I.; Johnston, H. (Lawrence Berkeley Lab., CA). *Journal of Physical Chemistry;* **86**: No. 18, 3611-3615(2 Sep 1982). Contract AC03-76SF00098.

The ultraviolet absorption cross sections for N_2O_5 are presented for wavelengths between 200 and 380 nm and for temperatures between 223 and 300 K. The absorption spectrum above 290 nm shows a pronounced temperature dependence. 2 figures, 4 tables.

30014 Nuclear, electronic, and frequency factors in electron-transfer reactions. Sutin, N. (Brookhaven National Lab., Upton, NY). *Accounts of Chemical Research;* **15**: No. 9, 275-282(Sep 1982). Contract AC03-76SF00098.

The crux of the problem is the fact that the equilibrium configuration of a species changes when it loses an electron. Configuration changes of organometallic metal complexes involve the metal-ligand and intra-ligand bond lengths and angles as well as changes in vibrations and rotation of surrounding solvent dipoles. Discussion indicates that rate constants can be expressed as a product of a nuclear, an electronic, and a frequency factor. Good agreement with measured rate constants is obtained in the normal free-energy region. Understanding of electron transfer rates in highly exothermic regions remains uncertain. 75 references, 2 figures, 2 tables.

30015 Silicon-carbon double bond: a healthy rivalry between theory and experiment. Schaefer, H.F. III. (Lawrence Berkeley Lab., CA). *Accounts of Chemical Research;* **15**: No. 9, 283-290(Sep 1982). Contract AC03-76SF00098.

One development in silaolefin chemistry has been the preparation of the first adamantyl-substituted silaethylene which is stable at room temperature. It has been characterized by ir, NMR, and mass spectroscopy. Another key discovery was the first convincing demonstration of the laboratory preparation of the unsubstituted parent silaethylene. A brief outline of these developments is presented. Other aspects of silaolefin chemistry are described. Theory is expected to play a significant role. 3 figures, 2 tables.

30016 Hollow microspheres of silica glass and method of manufacture. Downs, R.L.; Miller, W.J. (to Dept. of Energy). US Patent 4,336,338. 22 Jun 1982. Filed date 15 Aug 1980. vp.

PAT-APPL-178266.

A method of manufacturing gel powder suitable for use as a starting material in the manufacture of hollow glass microspheres having a high concentration of silica. The powder is manufactured from a gel containing boron in the amount of about 1% to 20% (oxide equivalent mole percent), alkali metals, specifically potassium and sodium, in an amount exceeding 8% total, and the remainder silicon. Preferably, the ratio of potassium to sodium is greater than 1.5.

30017 Preparation of metal phosphates by a reaction using boron phosphate. Bamberger, C.E. US Patent Application 6-379,801. 19 May 1982. 8p. Contract W-7405-ENG-26.

Metallic phosphates are prepared by heating mixtures of BPO_4 and a metallic oxide or salt.

30018 Infrared intensity and the CO-metal bond. Davenport, J.W. (Brookhaven National Lab., Upton, NY). *Chemical Physics Letters;* **77**: No. 1, 45-48(1 Jan 1981). Contract AC02-76CH00016.

It is argued that the frequency and intensity of the CO stretching modes in metal carbonyls can be explained without the usual σ donation and π back donation.

30019 Infrared spectra of matrix-isolated tungsten oxides. Green, D.W. (Argonne National Lab., IL); Ervin, K.M. *Journal of Molecular Spectroscopy;* **89**: 145-158(1981).

The infrared spectra of the WO, WO_2, and WO_3 molecules were observed in Kr and Ar matrices at 14 K. The vibrational constants of $W^{16}O$, ω/sub e/ and ω/sub e/x/sub e/, in both Ar and Kr matrices were derived from the measured frequencies of $W^{16}O$ and $W^{18}O$. The nu_1 and nu_3 mode absorptions of three WO_2 isotopomers were identified in krypton matrices and an upper limit to the bond angle of 119.4 +- 0.5° was determined. The true bond angle is estimated to be 114 +- 3°. The different effects of tungsten isotopes on the linewidths of the nu_1 and nu_3 absorption peaks of WO_2 were observed and are consistent with the calculated effects. The WO_3 molecule, whose spectrum was observed in Ar matrices and possibly in Kr, was found to be planar symmetric (D/sub 3h/). The observed lineshapes of WO_3 absorption peaks are consistent with the expected effects of tungsten isotopes in natural abundance.

30020 STEM and CTEM observations of interference between laue- and bragg-diffracted electrons in images of polyhedral crystals. Turner, P.S.; Cowley, J.M. (Arizona State Univ., Tempe). *Ultramicroscopy;* **6**: 125-138(1981).

Interference effects have been observed, using both TEM and high resolution STEM, at the edges of iamges of cubic MgO crystals oriented so that one (100) face is almost parallel to the electron beam. Electron waves entering or leaving this face at a glancing angle will be refracted through a small angle. They thus provide sets of waves, slightly inclined to both the directly transmitted waves and the waves diffracted in the crystal, giving sets of interference fringes in the out-of-focus images, parallel to the crystal edges. In the simplest cases, the fringe pattern is sinusoidal and may be simply related to the relative angle of deviation between the waves, and hence to the crystal inner potential. In general, the phenomena are very sensitive to the degree of perfection and cleanliness of the crystal surfaces. They are especially so when a wave strikes a crystal face at a glancing angle from within the crystal and undergoes total internal reflection.

30021 Anharmonicity and bond angle of matrix-isolated ozone. Green, D.W. (Argonne National Lab., IL); Ervin, K.M. *Journal of Molecular Spectroscopy;* **88**: 51-63(1981).

The vibrational frequencies of the six antisymmetric stretching modes of the ozone isotopomers, $^{16}O_3$, $^{16}O_2$, ^{18}O, ..., $^{18}O_3$, in both Ar and Kr matrices have been measured (+- 0.05 cm^{-1}). Upper and lower limits to the valence bond angle have been calculated and compared to each other and to the gas-phase bond angle. Derived values of the anharmonicity of the antisymmetric stretching mode ($2X_{33} + (1/2)X_{13} + (1/2)X_{33}$) of O_3 are -41.65 +- 1.5 cm^{-1} in Ar and -44.18 +- 1.5 cm^{-1} in Kr. The ozone molecule has very anharmonic antisymmetric vibrations compared with other known molecules. The bond angles of O_3 in both Ar and Kr, which were derived from measured frequencies including the effects of anharmonicity, agree with one another within the experimental uncertainity (0.4°) and these angles are also in agreement with the gas-phase angle, 116.8 +- 0.5°. It was concluded that, in general, bond angle determination from the frequencies of antisymmetric stretching modes of isotopomers cannot be done accurately without information about the vibrational anharmonicity. 4 figures, 5 tables.

30022 Interlayer bonding in IIb chlorite. Bish, D.L. (Harvard Univ., Cambridge, MA); Giese, R.F. Jr. *American Mineralogist;* **66**: 1216-1220(1981).

The interlayer bond energy of a IIb-4 chlorite has been calculated as a function of layer charge, the site of the charge and the selective replacement of hydroxyl groups by fluoride ions. Long hydrogen bonds between the hydroxide sheet and the adjacent oxygens are strong and by themselves sufficient to create a stable structure. Coupled substitutions giving the 2:1 layer a negative charge and the hydroxide sheet a positive charge increase substantially the interlayer bond energy. 3 figures.

30023 Studies of the structure and bonding of inorganic clusters. Peterson, K.I.; Holland, P.M.; Keesee, R.G.; Lee, N.; Maerk, T.D.; Castleman, A.W. Jr. (Univ. of Colorado, Boulder). *Surface Science;* **106**: 136-145(1981). Contract AC02-78EV04776.

Thermodynamic properties are given for the reactions: $Na^+(SO_2)$/sub n/ + SO_2 reversible $Na^+(SO_2)$/sub n+1/, n = 1 to 3; $Ag^+(H_2O)$/sub n/ + H_2O reversible $Ag^+(H_2O)$/sub n+1/, n = 0 to 5; $Ag^+(NH_3)$/sub n/ + NH_3 reversible $Ag^+(NH_3)$/sub n+1/, n = 2 to 4. Comparisons are made, using these and previous data,

between Na^+ and Cl^- in the clustering of H_2O and SO_2 and between Ag^+, K^+, and Na^+ in the clustering of H_2O and NH_3. 5 figures 1 table.

30024 **Chemisorption of hydrogen on titanium: embedding theory and comparisons with small clusters.** Cremaschi, P.; Whitten, J.L. (State Univ. of New York, Stony Brook). *Surface Science;* **112**: 343-358(1981). Contract AC02-77ER04387.

The chemisorption of H_2 on Ti(0001) is treated using an ab initio CI theory for the surface region. Dissociation of H_2 occurs above the surface but more stable 3-fold coordination sites lie closer to the surface at ~ 1.3 A. Adsorption in adjacent 3-fold sites is less stable than in separated sites sharing only one surface atom. The calculated adsorption energy of 45 kcal/mol H_2 compares favorably with experiment. Bonding involves mainly the 4s electrons of the metal leading to hydridic hydrogens and a polarized lattice electron distribution, but d bonding and correlation effects significantly increase the binding energy. Calculations on small metal clusters also show dissociative adsorption but much larger hydrogen binding energies are obtained. 2 figures, 6 tables.

30025 **Structure of sodium methanesulfonate.** Wei, C.H.; Hingerty, B.E. (Oak Ridge National Lab., TN). *Acta Crystallographica, Section B: Structural Crystallography and Crystal Chemistry;* **37**: 1992-1997(1981). Contract W-7405-ENG-26.

Sodium methanesulfonate, $NaCH_3SO_3$, crystallizes in the orthorhombic system, space group Pbma, with a = 17.0713 (6), b = 22.0217 (6), c = 5.6058 (3) A, Z = 20, V = 2107.4 A^3, D/sub c/ = 1.861, D_o = 1.88 Mg m^{-3} (flotation in bromobenzene/$CHBr_3$), M/sub r/ = 118.09, F(000) = 5200, μ(CuKα) = 6.55 mm^{-1}, transmission = 0.294 to 0.822 at 297°K. The structure was solved by the heavy-atom technique and refined by the full-matrix least-squares method to R(F) = 0.027 based on 1953 nonzero counter data to 0.83 A. Analytical absorption and anisotropic extinction corrections were applied. The asymmetric unit contains 2.5 molecules, with one $CH_3SO_3^-$ anion on the crystallographic mirror plane in the b direction and one Na^+ ion on a crystallographic two-fold axis in the c direction. All anions have approximate C/sub 3v/ symmetry, and their molecular parameters are within the expected ranges. Two Na^+ ions are each surrounded by six O atoms, forming distorted octahedral configurations with Na-O distances ranging from 2.276 (2) to 2.669 (1) A, whereas the third Na^+ is surrounded by eight O atoms with Na-O distances ranging from 2.318 (1) to 3.099 (1) A.

30026 **Enthalpy of formation of FeF_3 by fluorine bomb calorimetry.** Johnson, G.K. (Argonne National Lab., IL). *Journal of Chemical Thermodynamics;* **13**: 465-469(1981).

The energy of combustion of iron in fluorine was measured in a bomb calorieter. The standard enthalpy of formation of crystalline FeF_3, $\Delta H°$/sub f/(FeF_3, c, 298.15 K), was derived to be -(989.6 +- 2.2) kJ mol^{-1}.

30027 **Coordination cluster theory of solutions.** Blander, M.; Saboungi, M.L. (Argonne National Lab., IL). pp 223-231 of Chemical metallurgy: a tribute to Carl Wagner. Gokcen, N.A. (ed.). Albany, Oregon; Bureau of Mines (1981).

From 110. AIME annual meeting; Chicago, IL, USA (23 Feb 1981).

The coordination cluster theory (CCT) of solutions is a general statistical mechanical theory for activity coefficients of a dilute solute in a multicomponent solvent. The parameters in the theory are identified with physical interactions between atoms (or ions or molecules) in solution. Other theories such as those of Wagner, Alcock and Richardson, Jacob, and Alcock, Lupis, and Mathieu are limiting cases of the CCT. A simplification of the formal derivation of the theory has led to its application to a variety of types of solvents including substitutional and interstitial alloys, reciprocal and additive molten salt systems, slags and aqueous based mixed solvents.

30028 **Ammonium nitrate with 15 wt % potassium nitrate-ethylenediamine dinitrate-nitroguanidine system.** Spencer, W.; Cady, H.H. (Los Alamos Scientific Lab., NM). *Propellants and Explosives;* **6**: 99-103(1981).

The phase diagram for the ternary system ammonium nitrate(AN) with 15 wt % potassium nitrate(AN:15KN)-ethylenediamine dinitrate(EDD)-nitroguanidine(NQ) has been determined from room temperature to the melting point. The ternary eutectic temperature, measured for a mixture containing 67.24, 25.30, and 7.46 mole % of AN:15KN, EDD, and NQ, respectively, was found to be 98.9°C. The binary phase diagrams for the systems AN:15KN-EDD, AN:15KN-NQ, and EDD-NQ were also determined.

30029 **Solubility of antimony metal in molten antimony (III) chloride-aluminum chloride and antimony (III) chloride-cesium chloride mixtures.** Soerlie, M.; Smith, G.P. (Oak Ridge National Lab., TN). *Journal of Inorganic and Nuclear Chemistry;* **43**: No. 5, 931-934(1981). Contract W-7405-ENG-26.

The solubuility of antimony metal in molten $SbCl_3$-$AlCl_3$ and $SbCl_3$-CsCl is reported. Measurements were made at many compositions and temperatures within the following ranges: $SbCl_3$-$AlCl_3$ system, 1-90 mol % $AlCl_3$ at 235-430°C; $SbCl_3$-CsCl system, 0.5-25 mol % CsCl at 405°C, 45-80 mol % CsCl at 628°C and 60 mol % CsCl at 562-642°C. The solubility is attributed to the reversible reaction of antimony metal with antimony (III) in the melts to form two types of species with oxidation states below 3+. One type is stabilized in $SbCl_3$-$AlCl_3$ melts at high rho Cl (rho Cl = -log $[Cl^-]$) and the other is stabilized in $SbCl_3$-CsCl melts with low rho Cl. Both types are present in melts with a high concentration of $SbCl_3$, but it is in such melts that antimony metal has its lowest solubility. 5 figures, 2 tables.

30030 **Ab initio molecular orbital calculations on beryllium and magnesium atom reactions with water.** Curtiss, L.A.; Frurip, D.J. (Argonne National Lab., IL). *Chemical Physics Letters;* **75**: No. 1, 69-74(1 Oct 1980).

Ab initio molecular orbital calculations are reported for beryllium and magnesium atom complexes with water, Be...OH_2 and Mg...OH_2, and for species resulting from insertion of the metal atom(s) into the water molecule, HBeOH, HMgOH, HBeOBeH, and HMgOMgH. 18 references, 1 figure, 4 tables.

30031 **Computer analysis of phase diagrams and thermodynamic properties of cryolite based systems: 1. The AlF_3-LiF-NaF system.** Saboungi, M.L. (Argonne National Lab., IL); Lin, P.I.; Cerisier, P.; Pelton, A.D. *Metallurgical Transactions, [Section] B: Process Metallurgy;* **11**: 493-501(Sep 1980).

Calculations of the phase diagram of the AlF_3-LiF-NaF system up to 35 mol pct AlF_3 and of the binary subsystems are presented. For the binary LiF-NaF, AlF_3-NaF, AlF_3-LiF, and the quasibinary Li_3AlF_6-Na_3AlF_6 systems, thermodynamic properties of the unary and binary phases are used to numerically generate the corresponding phase diagram. The calculated and measured values are in good agreement. The broad data base thus constructed is used with equations from the conformal ionic solution theory to derive a priori phase equilibria of the AlF_3-LiF-NaF system. Ternary liquidus temperatures are calculated covering compositions outside the range of measurements. 47 references, 7 figures, 2 tables.

30032 **Current-voltage characteristics of Li-doped MgO oxidized at elevated temperatures.** Chen, Y.; Abraham, M.M.; Boldu, J.L.; Orera, V.M. (Oak Ridge National Lab., TN). *Journal de Physique (Orsay, France);* **41**: No. 7, C6.398-C6.400(Jul 1980). Contract W-7405-ENG-26.

The current density has been measured as a function of the electric field (I vs. E) at 295 K on MgO single crystals containing stable $[Li]^0$ centers (Li^+ 0^- complexes), produced by heat treatment in flowing oxygen. Whereas the treatment temperature has a pronounced influence on the $[Li]^0$ concentration, electrical conductivity and the non-linearity of the I-E curve, thermal aging has considerably less effect.

30033 Analysis of the Fourier transform spectra of $^{12}C^{17}O_2$ and $^{12}C^{17}O^{18}O$: the nu_2 (15 μm) region. Reisfeld, M.J.; Flicker, H.; Goldblatt, M. (Los Alamos Scientific Lab., NM). *Journal of Molecular Spectroscopy;* **82**: 411-417(1980).

The vibration-rotation spectra of the nu_2 fundamental of $^{12}C^{17}O^{18}O$ have been obtained by Fourier transform spectroscopy at 0.05 cm^{-1} resolution. The data were fitted by a least-squares routine to obtain a number of the molecular constants. The band center for $^{12}C^{17}O_2$ lies at 662.0716 cm^{-1} while that for $^{12}C^{17}O^{18}O$ is at 659.7057 cm^{-1}. The difference bands nu_1 - nu_2 have also been observed for the two molecular species.

30034 Raman spectra of molten $SbCl_3/AlCl_3$ mixtures. Huglen, R. (Tennessee Univ., Knoxville); Mamantov, G.; Begun, G.M.; Smith, G.P. *Journal of Raman Spectroscopy;* **9**: No. 3, 188-192(1980). Contract W-7405-ENG-26.

Raman spectra were obtained for nine molten mixtures of $SbCl_3$ and $AlCl_3$ as well as for the pure components. Also three molten mixtures of $AlCl_3$/NaCl/$SbCl_3$ were studied. Molten $AlCl_3$ contains molecular Al_2Cl_6 (D/sub 2h/)while molten $SbCl_3$ contains pyramidal (C/sub 3v/) molecules aligned head to tail. The Raman spectra showed the presence of Al_2Cl_6 molecules in molten $SbCl_3$/$AlCl_3$ mixtures containing 40 mol % or more $AlCl_3$ but gave no evidence for the formation of $SbCl_3^+$ and $AlCl_4^-$. However, $SbCl_3$ is structurally modified by the addition of $AlCl_3$ as seen from the shift of the highest Sb--Cl stretching frequency. There is also spectral evidence that points to the formation of polymers that are different from those in pure $SbCl_3$, and it cannot be ruled that there may be a chloride-deficient antimony species in the $AlCl_3$-rich mixtures. The molecular nature of the observed modifications in these mixtures cannot be deduced solely on the basis of the recorded spectra. 21 references, 3 figures, 3 tables.

30035 Anomalous scattering by cobalt and chlorine and crystal structure of (+)-tris(ethylenediamine)cobalt(III) chloride (+)-tartrate pentahydrate. Templeton, D.H.; Zalkin, A.; Ruben, H.W.; Templeton, L.K. (Univ. of California, Berkeley). *Acta Crystallographica, Section B: Structural Crystallography and Crystal Chemistry;* **35**: 1608-1613(1979).

Crystals of $[Co(C_2H_8N_2)_3]^{3+}$ $C_4H_4O_6^{2-}$ Cl^- $5H_2O$, are triclinic, space group P1 with a = 8 261 (3), b = 8 507 (3), c = 8 149 (3) A, α = 101 21 (1), β = 95 27 (1), γ = 102 31 (1)°, Z = 1. The structure and absolute configuration, Λ for (+)-Co(en)$_3$, were determined with 7688 observed reflections (Mo Kα radiation) refined to R = 0 022. All H-atom positions were refined. These data and 3198 reflections measured with Cu Kα radiation (R = 0 029) were used to determine anomalous-scattering terms. At MoKα, f"(Co) = 0 962 (10); f"Cl) = 0 155 (10. At Cu Kα, f', f"(Co) = -2 36 (2), 3 92 (2); f', f" (Cl) = 0 23 (2), 0 72 (2) electrons.

30036 (RFP-Trans—398) Some thermodynamic properties of molten binary mixtures of alkaline-earth and alkali-metal chlorides. Emons, H.H.; Braeutigam, G.; Thomas, R. Translated from *Chemicke Zvesti ;* **32**: No. 6, 721-733(1978). Contract AC04-76DP03533. 13p. NTIS, PC A02/MF A01. Order Number DE83010451.

Portions are illegible in microfiche products.

Thermodynamic quantities a/sup i/ f/sub i/ ΔG/sup E/ ΔH/sup E/ and ΔS/sup E/ were calculated on the basis of vapor pressure measurements in molten mixtures of the type alkaline earth metal chloride-alkali metal chloride. For the systems $CaCl_2$-KCl, $SrCl_2$-(Na K)Cl, and $BaCl_2$-(Na K)Cl there is a good agreement with the corresponding values determined by means of other methods (EMF-measurements, cryoscopy). The thermodynamic quantities calculated for the systems RbCl-(Ca, Sr, Ba)Cl_2 indicate a pronounced negative deviation from ideality. As to the enthalpy of mixing, the experimentally determined values agree within the experimental error with the values calculated on the basis of the temperature dependence of the free enthalpy. 10 figures, 8 tables.

30037 Crystal structures of $[Xe_2F_3^+][AsF_6^-]$ and $[XeF_5^+][AsF_6^-]$. Bartlett, N.; DeBoer, B.G.; Hollander, F.J.; Sladky, F.O.; Templeton, D.H.; Zalkin, A. (Lawrence Berkeley Lab., CA). *Inorganic Chemistry;* **13**: No. 4, 780-785(1974).

Crystals of $[Xe_2F_3^+][AsF_6^-]$ are pale yellow-green. The crystalline modification which is stable at room temperature is monoclinic. The AsF_6^- species are roughly octahedral, the six As-F distances being in the range 1.56 (3)-1.70 (3) A and the cis F-As-F bond angles in the range 83 (2)-95 (2)°. The average As-F distance is 1.63 (4) A. The cation is V shaped [F-Xe-F-Xe-F]$^+$ and is planar and symmetrical about the bridging F atom. The average of the terminal Xe-F distances is 1.90 (2) A, the average bridging distance is 2.14 (2) A, and the F(terminal)-Xe-F(bridge) angle is not significantly different from 180°. The average bridge Xe-F-Xe angle is 150.2 (8)°. Crystals of $[XeF_5^+][AsF_6^-]$ are colorless. The unit cell is monoclinic. R factor was obtained of 0.12 for 925 independent reflections for which I greater than or equal to sigma(I). The asymmetric structural unit contains one XeF_5^+ and one AsF_6^-. The XeF_5^+ has approximately C/sub 4v/ symmetry, with the Xe-F axial distance 1.78 (2) A, the average Xe-F equatorial distance 1.83 (2) A, and the average F(axial)-Xe-F(equatorial) angle 80 (1)°. The AsF_6^- group is somewhat distorted from O/sub h/ symmetry with bond lengths in the range 1.76 (2)-1.65 (2) A. The average As-F distance is 1.72 (3) A. The coordination of the cation is similar to that observed in the $[XeF_5^+]_2[PdF_6^{2-}]$ structure.

4003 Organic Chemistry

REFER ALSO TO CITATION(S) 28792, 28793, 28996, 28997, 29043, 29044, 29104, 29287, 29288, 29291, 29952, 30001, 30012, 30014, 30015, 30018, 30025, 30027, 30028, 30035, 30067, 30079, 30328, 30420

30038 (AD-A—122649/7) Synthesis of new prophylactic antiradiation drugs. Progress report no. 2 (annual), 1 Aug 80-31 Jul 81. Bauer, L. (Illinois Univ., Chicago (USA). Dept. of Medicinal Chemistry). Aug 1981. 29p. NTIS, PC A03/MF A01.

This report presents details of the work done on the project (covered) during the last 12 months. Approaches to the synthesis of a number of 3-aryl l-(omega-aminoalkyl) adamantanes is described. Their final incorporation in the preparation of N-(adamantylalkyl) alpha-mercapto acetamidines, and derivatives, as potential antiradiation drugs is projected. The report divided into two major sections. The first deals with the preparation of 1,3-bis(2-aminoethyl) adamantane and its conversion to the disulfide of 1,3-bis(2-(mercaptomethylcarboxamidino) ethyl)-adamantane. The next section describes the synthesis of some 3-aryl-l-adamantanecarboxylic and acetic acids, 12 (n=0 or 1, respectively). These are the vital precursors needed for the synthesis of the essential 3-aryl (l-adamantylmethyl and ethylamines), 11, which will be a part of the N-substituent of the target alpha-mercaptoacetamidines and derivatives.

30039 (CONF-830308—9) Amphiphilic properties of low-equivalent-weight organic salts. Ho, P.C. (Oak Ridge National Lab., TN (USA)). 1983. Contract W-7405-ENG-26. 20p. NTIS, PC A02/MF A01. Order Number DE83010145.

From American Insititute of Chemical Engineers national meeting; Houston, TX, USA (27 Mar 1983).

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The amphiphilic properties of low-equivalent-weight organic salts of sodium benzene sulfonates, carboxylates, and salicylates are under study. These organic salts, which we refer to as protosurfactants resemble petroleum surfactants which possess a polar head group and hydrophobic nonpolar tails. The difference between protosurfactants and surfactants is that the alkyl chains of the former are shorter than usually is thought necessary for formation of micelles in aqueous solutions. The amphiphilic properties of these protosurfactants resemble those of surfactants in that they tend to increase the solubility of materials normally slightly soluble in water. In multi-component systems containing protosurfactants along with hydrocarbons, water, inorganic salts, and cosurfactants, phase behavior and thermodynamic properties are similar to those of surfactant systems. In the past few years we have published several papers on the effect of organic hydrotropic salts on solubility of hydrocarbon in either water, or aqueous/alcohol systems, and on phase behaviors of these compounds in multicomponent systems. In this paper we present extensions of earlier results and compare phase behavior of protosurfactants to surfactants in corresponding systems. 7 figures.

30040 (DOE/ER/04047—T1) Kinetic, magnetic and Moessbauer studies on porphyrin systems. Final report. Hambright, P. (Howard Univ., Washington, DC (USA). Dept. of Chemistry). 25 Apr 1980. Contract AS05-76ER04047. 13p. NTIS, PC A02/MF A01. Order Number DE83010305.

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This project explored aspects of the coordination chemistry of porphyrin molecules:cyclic, conjugated tetrapyrrole pigments. Specific areas investigated are discussed briefly. These are: (1) mechanisms of incorporation of metal ions into porphyrin molecules; (2) metal-porphyrin equilibria; (3) acid catalyzed solvolysis reactions; (4) metal exchange reactions; (5) metalloporphyrin ligation; (6) metallo deligation; (7) dimerization; (8) redox reactions; (9) anation rate studies; (10) electrochemical work; (11) magnetic and Moessbauer studies; (12) tumor agents; (13) multimetal chelating agents; (14) superoxide dimutase models; and (15) laser dyes. Seventy-seven publications are listed.

30041 (LA-UR—83-964) Reaction of fluorine and chlorine atoms with formaldehyde and deutero-formaldehyde. Nogar, N.S.; Fasano, D.M. (Los Alamos National Lab., NM (USA); Nebraska Univ., Lincoln (USA). Dept. of Chemistry). 1983. Contract W-7405-ENG-36. 8p. (CONF-830425—8). NTIS, PC A02/MF A01. Order Number DE83009909.

From Society of Photo-Optical Instrumentation Engineers conference; Santa Fe, NM, USA (11 Apr 1983).

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The following reactions were studied by using infrared multiple photon dissociation to produce fluorine atoms, and infrared chemiluminescence to monitor the rate of reaction: $Cl + H_2O \rightarrow HCl + HCO$; $F + H_2CO \rightarrow HF + HCO$; $Cl + D_2CO \rightarrow DCl + DCO$; and $F + D_2CO \rightarrow DF + DCO$.

30042 Analysis of hydrocarbon chain conformation using double quantum coherence ^{13}C NMR. Phillippi, M.A. (Clorox Technical Center, Pleasanton, CA); Wiersema, R.J.; Brainard, J.R.; London, R.E. *Journal of the American Chemical Society;* **104**: No. 25, 7333-7334(15 Dec 1982).

The recent development of a double quantum coherence method for the observation of ^{13}C-^{13}C scalar coupling constants without the need for isotopic labeling provides an alternative approach to the hydrocarbon chain conformation problem. The method is particularly suitable for this application since one-, two-, and three-bond carbon-carbon coupling constant values in hydrocarbons are typically of significantly different magnitudes, and observation of coupling constants of selected magnitude may be enhanced by the appropriate choice of pulse intervals. Consequently, J/sub CC/ values, which are dependent on the subtended dihedral angle, can be selectively observed. In order to evaluate the potential of this approach, studies on a 90% octanol-10% benzene-d_6 solution, with the latter serving for the deuterium lock were carried out. A representative ^{13}C double quantum coherence spectrum of the region containing the octanol C-7 resonances with pulse intervals chosen to optimize couplings with magnitude close to 4.0 Hz is illustrated.

30043 Viscosity dependence of the rotational reorientation of rhodamine B in mono- and polyalcohols. Picosecond transient grating experiments. Moog, R.S.; Ediger, M.D.; Boxer, S.G.; Fayer, M.D. (Stanford Univ., CA). *Journal of Physical Chemistry;* **86**: No. 24, 4694-4700(25 Nov 1982). Contract FG02-80CS84006.

Rotation reorientation times (tau/sub ROT/) were obtained for rhodamine B in a series of n-alcohols and polyalcohols of varying viscosities by a transient grating technique. The general trend of the Debyc-Stokes-Einstein (DSE) theory was shown to extend to much higher viscosities than previously reported. Detailed analysis of the results suggests that the n-alcohols and polyalcohols provide two distinct hydrodynamic boundary conditions for the rotating species. In the n-alcohols, stick boundary conditions are observed, while the polyalcohols provide approximately slip boundary conditions. The question of a difference in the rotation times for the ground and excited electronic states is addressed and an upper bound is placed on this difference for rhodamine B.

30044 Interaction of nonbonding orbitals in 1,3-cyclobutanedione systems. Pasto, D.J.; Chipman, D.M.; Huang, N.Z. (Univ. of Notre Dame, IN). *Journal of Physical Chemistry;* **86**: No. 20, 3990-3992(30 Sep 1982).

Prior theoretical and experimental studies on the highest occupied orbitals in 1,3-cyclobutanedione systems have concluded that the n + n combination of oxygen nonbonding orbitals lies higher in energy than the n - n combination. In this paper ab initio calculations at several levels of theory are presented that show the previous assignment to be incorrect, i.e., n - n is found to be above n + n. The calculations also provide an explanation of the PES line shapes. The nature of the interaction is further analyzed by a correlation diagram based on appropriate fragment orbitals. As a corollary, it is deduced that the excited-state π^* orbitals describing $n\pi^*$ transitions must have $\pi^* - \pi^*$ above $\pi^* + \pi^*$ in energy.

30045 Electron nuclear double resonance study of the spin-label tanol (tempol) oriented in the inclusion compound 2'-hydroxy-2,4,4,7,4'-pentamethylflavan. Ohzeki, F.; Kispert, L.D.; Arroyo, C.; Steffan, M. *Journal of Physical Chemistry;* **86**: No. 20, 4011-4016(30 Sep 1982).

The nitrogen quadrupole tensor has been determined by ENDOR measurements at -20°C for the spin-label tanol (tempol) oriented in the inclusion compound 2'-hydroxy-2,4,4,7,4'-pentamethylflavan. The principal values are equal to +1.46, +0.11, and -1.57 MHz, with the direction of the 1.46-MHz quadrupole coupling lying parallel to the direction of the largest nitrogen hyperfine coupling. The other two quadrupole tensor components do not lie parallel to the remaining nitrogen hyperfine coupling directions nor are the couplings cylindrically symmetric. Two exchangeable protons are observed to be strongly dipolar coupled to the electron. Coupling constants and direction cosines for nine weekly coupled protons were deduced and attempts were made to assign them.

30046 High-spin electronic states of the experimentally observed molecular ions $MnCH_2i$ and $CrCH_2^+$. Vincent, M.A.; Yoshioka, Y.; Schaefer, H.F. III. (Univ. of California, Berkeley). *Journal of Physical Chemistry;* **86**: No. 20, 3905-3906(30 Sep 1982). Contract W-7405-ENG-48.

The $^7B_1$ electronic state of $MnCH_2^+$ and $^6B_1$ state of $CrCH_2^+$ have been investigated with nonempirical molecular electronic structure theory. Large Gaussian basis sets were used in conjunction with explicity correlated wave functions. Equilibrium geometries were predicted at the self-consistent-field level of theory, yielding for $MnCH_2^+$ r/sub e/(Mn-C) = 2.076 angstrom, Θ/sub e/(HCH) = 114.5° and for $CrCH_2^+$ r/sub e/(Cr-C) = 2.064 angstrom, Θ/sub e/(HCH) = 113.5°. The M^+-CH_2 bond dissociation energies for these high-spin electronic states are significantly less than the ground-state bond energies deduced from laboratory measurements by Beauchamp and co-workers. This comparison suggests that the true electronic ground states of $MnCH_2^+$ and $CrCH_2^+$ may be the lower spin quintet and quartet states, respectively.

30047 Relative stability of cations and anions of conjugated polycyclic hydrocarbons. Randic, M. (Ames Lab., IO). *Journal of Physical Chemistry;* **86**: No. 20, 3970-3977(30 Sep 1982). Contract W-7405-ENG-82.

Cations and anions for a number of conjugated polycyclic systems are examined from graph theoretical positions. The concept of conjugated circuits, already found useful for classification of neutral conjugated systems, is here extended to and modified for conjugated ions. By the enumeration of conjugated circuits of different sizes, some of which may involve a formal charge, one can estimate the molecular resonance energies of positive and negative monoions of polycyclic systems. The results show that for some polycyclic systems the cation and the corresponding anion have same resonance energies. In such cases the conjugated circuits in all Kekule valence structures of both ions do not involve a formal charge. In some cases the predicted resonance energies are greater for anions than cations, while in others the reverse is the case. The analysis allows one to deduce for the ions of interest the relative role of the aromatic and antiaromatic contributions, based on the partition of the molecular resonance energy, which may be relatively large, but still the compound may have significant lack of aromaticity due to "antiaromatic" contributions present.

30048 **Comparison of through-space and through-bond interactions in four-membered ring systems.** Pasto, D.J. (Univ. of Notre Dame, IN); Chipman, D.M.; Worman, J.J. *Journal of Physical Chemistry;* **86**: No. 20, 3981-3989(30 Sep 1982).

Numerous authors have discussed the interactions between nondirectly bonded functions in terms of direct "through-space" orbital interactions and/or "through-bond" orbital interactions. In this study, ab initio interaction energies are calculated for 1,3-located functions in the four-membered ring systems cyclobutane and all mono- and 1,3-diheterocyclobutanes obtainable with oxygen, sulfur, and carbonyl functions, systems in which the through-space interactions should be maximal due to the close proximity of the interacting functions. Through-space and through-bond interactions are separated from one another by performing the calculations both in the absence and in the presence of the methylene groups that indirectly bond together the 1- and 3-located functions. In all cases the through-bond interaction energies are found to be greater than the through-space interaction energies by factors ranging from 3- to 25-fold.

30049 **Electron paramagnetic resonance studies of thermally produced radicals in phenylacetylene.** Sipe, H.J. Jr. (Univ. of Alabama, Tuscaloosa); Kispert, L.D.; Hwang, J.S.; Tsonis, C.P. *Journal of Physical Chemistry;* **86**: No. 20, 4017-4019(30 Sep 1982).

EPR observations of the thermal polymerization of phenylacetylene suggest a phenyl-substituted polyenyl-πelectron radical as an intermediate. Failure to observe radical production and polymerization for phenylpropyne under similar conditions indicates that the C-H bond is the reactive site in phenylacetylene. INDO MO calculations based on such an intermediate predict EPR hyperfine couplings in general agreement with those found experimentally and imply that the polymerization mechanism at the initiation step is head-tail-tail-head.

30050 **Crossed molecular beam studies of the reaction of $O(^3P)$ with C_2H_3Br.** He, G.; Buss, R.J.; Baseman, R.J.; Tse, R.; Lee, Y.T. (Lawrence Berkeley Lab., CA). *Journal of Physical Chemistry;* **86**: No. 18, 3547-3553(2 Sep 1982). Contract AC03-76SF00098.

The reaction of $O(^3P)$ with C_2H_3Br has been studied in a crossed molecular beam experiment with rotatable mass-spectrometric detector. Three major reaction routes were identified giving products H + C_2H_2BrO, CH_2Br + CHO, and Br + C_2H_3O. Relative product yields were measured at two collision energies, 7.4 and 12.4 kcal/mol. The product translational energy distributions were determined for each reaction and are compared to statistical calculations. The center-of-mass angular distributions of the products indicate that the hydrogen elimination and the C-C bond cleavage occur from dissociation of a complex with a lifetime greater than a rotational period while the Br atom elimination is somewhat faster. 7 figures, 1 table.

30051 **Ionization energies and entroples of cycloalkanes. Kinetics of free energy controlled charge-transfer reactions.** Sleck, L.W.; Mautner, M. (National Bureau of Standards, Washington, DC). *Journal of Physical Chemistry;* **86**: No. 18, 3646-3650(2 Sep 1982).

Enathalpies and entropies of ionization ($\Delta H°$/sub ion/ and $\Delta S°$/sub ion/) of alkylcyclohexanes, as well as cycloheptane, cyclooctane, and trans-Decalin, have been determined by charge-transfer equilibrium measurements. Values of ΔH/sub ion/, in units of kcal mol^{-1} (or eV), range from 229.6 (9.96) for cycloheptane to 210.7 (9.14) for trans-Decalin. A major effect of alkyl substitution is observed following substitution at a site α to a tertiary hydrogen atom (as from methylcyclohexane to 1,2-dimethylcyclohexane), or following replacement of a tertiary hydrogen atom (as from methylcyclohexane to 1,1-dimethylcyclohexane). In both cases, $\Delta H°$/sub ion/ decreases by ca. 5 kcal mol^{-1}. Entropies of ionization are near zero for alkylcyclohexanes but range up to 5 cal $deg^{-1}mol^{-1}$ for nonsubstituted cycloalkanes (cyclooctane). The sum of the reaction efficiencies (r = k/k/sub collision/) of the forward and reverse processes of charge-transfer is near unity.

30052 **Laser-excited infrared fluorescence in oxalyl fluoride. Relaxation in the presence of a low-energy, one-dimensional quasicontinuum.** Allik, T.H.; Flynn, G.W. (Columbia Univ., New York, NY). *Journal of Physical Chemistry;* **86**: No. 18, 3673-3677(2 Sep 1982). Contract AC02-78ER04940.

Fluorescence has been observed from various fundamental and combination states of oxalyl fluoride excited by a Q-switched CO_2 laser. The presence of a low-frequency torsional mode in this molecule provides a one-dimensional quasicontinuum of vibrational levels at energies above the barrier to rotation about the C-C bond. Intermode vibrational relaxation rates in $(COF)_2$ are extremely rapid (possibly collisionless). The observed temperature dependence of fluorescence intensity and the overall rapid equilibration in $(COF)_2$ suggest a mechanism in which many rovibrational transitions that possess nu_{10} character (e.g., 0 → nu_{10}, nu_{10} → 2 nu_{10}, nu/sub x/ → nu/sub x/ + nu_{10}, etc.) are excited by the laser. 3 figures.

30053 **Photochemistry in ultrahigh laboratory magnetic fields. Photolysis of micellar solutions of dibenzyl ketones at 145,000 G. observation of a Δg vector H effect on the cage reaction.** Turro, N.J. (Columbia Univ., New York, NY); Chung, C.J.; Jones, G. III; Becker, W.G. *Journal of Physical Chemistry;* **86**: No. 18, 3677-3679(2 Sep 1982).

The extent of recombination of benzyl radical and/or substituted benzyl radical pairs produced in micelle aggregates depends on the strength of the external laboratory field applied to the sample. 1 figure, 2 tables.

30054 **Bridged ferrocenes. VII. Synthesis of di- and tribridged ferrocenes with pentamethylene chains.** Hisatome, M.; Hillman, M. (Brookhaven National Lab., Upton, NY). *Journal of Organometallic Chemistry (Amsterdam);* **212**: 217-231(1981). Contract AC02-76CH00016.

Double or successive bridge-enlargement reactions were used on appropriate α-ketones followed by reduction to prepare 1,1'-pentamethyleneferrocene, VIII, 1,1',3,3'-bis(pentamethylene)ferrocene, XX, and 1,1',2,2',4,4'-tris(pentamethylene)ferrocene, XXX. The bridge-enlarging reactions are discussed, and the PMR spectral behavior of the polybridged ferrocenes is briefly discussed.

30055 **Trans-anti photodimer of 1-methylthymine: direct evidence of x-ray cleavage of dimer into monomers in the crystalline state.** Wei, C.H.; Einstein, J.R. (Oak Ridge National Lab., TN). *Acta Crystallographica, Section B: Structural Crystallography and Crystal Chemistry;* **37**: 410-414(1981). Contract W-7405-ENG-26.

The title compound, $(C_6H_8N_2O_2)_2$, is monoclinic, $P2_1/c$, with a = 7.5420 (3), b = 6.2277 (2), c = 14.4633 (5) A, β = 117.039 (3)°, Z = 2. Other pertinent information: D/sub x/ = 1.538 Mg m^{-3}, U = 605.08 A_3, F(000) = 296, $\mu(CuK\alpha)$ = 1.0026 mm^{-1}, transmission = 0.800 - 0.922, T = 297°K. The structure was solved by direct methods. Refinement yielded R(F) = 0.039 for 1052 nonzero counter data to 0.84 A. The dimer is of the trans-anti type, having a crystallographic center of symmetry at the center of its cyclobutane ring. The pyrimidine ring is folded along the N(1)...C(4) line with a dihedral angle of 163.6 (1)° between two planes each consisting of four ring atoms. About 4% of the molecules exist in the monomeric form, presumably because of prolonged x-irradiation. E.s.d.'s of bond lengths and angles involving C, N, O atoms are 0.002 A and 0.1°. Through pairs of centrosymmetrically related N(3)H...O(2) hydrogen bonds, the dimers form infinite chains in the [110] direction.

30056 **Crystal structure of (eta^5-C_5H_5)Mn(CO)$_2$-(eta^2-norbornadiene): the absence of a postulated C-H-metal interaction in an 18-electron complex.** Vella, P.A.; Beno, M.; Schultz, A.J.; Williams, J.M. (Argonne National Lab., IL). *Journal of Organometallic Chemistry (Amsterdam);* **205**: 71-78(1981).

The crystal and molecular structure of (eta^5-C_5H_5)Mn(CO)$_2$(eta^2-C_7H_8) has been determined at 170°K using single crystal x-ray diffraction. The complex crystallizes in the orthorhombic space group Pnma with lattice parameters of a = 11.986(5), b = 11.171(5), c = 8.837(5) A and Z = 4. The crystal

consists of discrete molecules of (eta^5-C_5H_5)Mn(CO)$_2$(eta^2-C_7H_8) with a distorted tetrahedral geometry around the central Mn atom. The molecule also possesses a mirror plane which bisects the eta^5-C_5H_5 ligand, the norbornadiene, and the OC-Mn-CO angle. The Mn atom is coordinated to the norbornadiene moiety in an exo configuration with one olefin bond not participating in metal bonding. The metal coordinated olefinic bond is significantly longer than a corresponding non-coordinated double bond. The distance between the Mn atom and one of the bridgehead methylene hydrogen atoms on the norbornadiene ligand is 2.97(5) A, which is indicative of the lack of a C-H...metal interaction.

30057 **Additivity of heats of atomization of benzenoid hydrocarbons.** Zivkovic, T. (Rugjer Boskovic Inst., Zagreb, Yugoslavia); Trinajstic, N.; Randic, M. *Croatica Chemica Acta;* 54: No. 3, 309-320(1981).

An additivity scheme, based on Clar's formulae, is proposed for calculating heats of atomization of benzenoid hydrocarbons. Comparison between the results obtained by this scheme, by the semiempirical SCF MO model, and experimental findings is good. This satisfactory agreement, thus, presents independent support for Clar's notion of isolated π sextets and migrating sextets.

30058 **Di-rho-methylphenylphosphoric acid: the solid state structure of a unique dimeric hydrogen bonded phosphoric acid.** Gebert, E.; Reis, A.H. Jr.; Peterson, S.W.; Katzin, L.I.; Mason, G.W.; Peppard, D.F. (Argonne National Lab., IL). *Journal of Inorganic and Nuclear Chemistry;* 43: 1451-1464(1981).

Di-rho-methylphenylphosphoric acid, [rho-$CH_3C_6H_4O$]$_2$ PO(OH), HD(rho-Mphi)P, is the first phosphoric acid dimer to be characterized in the solid state. Two acid molecules are linked together by strong, 2.512(3)A, apparently centered, hydrogen bonds forming an eight-membered centrosymmetric ring. This x-ray structural result parallels IR spectral data showing the disappearance of the P = 0 stretching absorptions due to the formation of a nearly centered hydrogen bond. The two O-H distances in the hydrogen bond are O(1)-H(1) = 1.28(5) and O(2)-H(1) = 1.23(5)A with an O(1)-H(1)-O(2)' bond angle of 172(4)°. HD(rho-Mphi)P crystallizes in the centrosymmetric, triclinic space group, P anti 1, [C_1/sup i/, No. 2], with unit cell parameters a = 9.2700(17), b = 0.5384(14), c = 9.7308(15)A, α = 85.27(1), β = 62.34(1), γ = 65.53(1)° and Z = 2. Data were collected using a Syntex P2$_1$ automated diffractometer and the structure was solved by using a combination of direct methods, Fourier and least-squares refinement techniques to a final R/sub F/ = 0.040 for all 1408 independent data. The P-O bond lengths observed are: 1.489(2), 1.501(2), 1.559(2) and 1.570(2)A. 3 figures, 9 tables.

30059 **Coexistence curve of 2,6-lutidine + water, near its lower critical point.** Handschy, M.A.; Mockler, R.C.; O'Sullivan, W.J. (Univ. of Colorado, Boulder). *Chemical Physics Letters;* 76: No. 1, 172-174(15 Nov 1980). Contract AC02-76ER02203.

Measurements of the refractive index of both phases of the mixture 2,6-lutidine + water, near the lower critical point, are reported. For T-T/sub c/ < 0.5 K, a simple power law, Δn = (0.0471 +- 0.001)(T-T/sub c/)/sup (0.338 +- 0.003)/, describes the data. For 0.5 K < T-T/sub c/ < 15 K, a decorated lattice model better decribes the data. 1 figure, 1 table.

30060 **Dynamics of the photodecarbonylation of dibenzylketone in a micellar detergent solution: effect of temperature on the absolute quantum yields and on ^{13}C enrichment.** Turro, N.J. (Columbia Univ., New York, NY); Chow, M.F.; Kraeutler, B. *Chemical Physics Letters;* 73: No. 3, 545-549(1 Aug 1980).

An investigation is reported of the influence of temperature on the quantum efficiencies ^{13}C enrichment efficiency of photolysis of dibenzylketone in micellar solution. 1 figure, 1 table.

30061 **Identification by gas-liquid chromatography-mass spectrometry of low-molecular-weight products from the aqueous alkaline degradation of cellulose.** Molton, P.M.; Miller, R.K.; Donovan, J.M.; Demmitt, T.F. (Pacific Northwest Lab., Richland, WA). *Carbohydrate Research;* 75: 199-206(1979).

Low-molecular-weight products from the degradation of pure cellulose in 0.3 to 0.65M sodium carbonate or hydrogencarbonate at 300° have been identified by g.l.c.-m.s. Both the aqueous residual phase and the floating-oil product phase were examined, and contained essentially the same compounds, which were further characterized by the trifluoroacetyl derivatives. They consisted primarily of unsaturated aliphatic and alicyclic hydrocarbons, aldehydes, ketones, alcohols, and furans. Specifically identified were cyclopentanone, cyclohexanone, phenol, cresols, 2-ethyl-cyclopentanone, 2- or 3-methylcyclopentanone, 2,5-dimethyl-2-cyclopentenone, acrolein 2,5-dimethyl-2,4-hexadiene, and octene. Probably present were 2,4-dimethylfuran, 2,5-diethylfuran, ethylmethylfuran, 4-octyne, and decyne. The formation of these componds demonstrates not only the degradation of cellulose but the resynthesis of molecules with carbon-chain lengths greater than 6 atoms.

4004 Electrochemistry

REFER ALSO TO CITATION(S) 29877, 29887, 29966

30062 **(DOE/ER/14945—1) Electric field studies of the aggregation of electrolytes in low dielectric media. Final report.** Hemmes, P. (Rutgers--the State Univ., New Brunswick, NJ (USA). Dept. of Chemistry). [nd]. Contract AC02-78ER14945. 12p. NTIS, PC A02/MF A01. Order Number DE83010034.

Work completed for this project include the following: an optical detection electric field jump instrument was built using either a xenon arc lamp or an argon ion laser source, and was used to study the dimerization of methyl yellow; ultrasonic absorption measurements were made on $LiClO_4$ in pure 2-methyltetrahydrofuran and 2-methyltetrahydrofuran/tetrahydrofuran mixtures; electric conductivity studies showed evidence of extensive ionic association to ion pairs as well as the presence of triple ions in low concentration; a new technique, field modulation spectrometry, in combination with conductance studies was used to study ionic association of lithium-perchlorate in various mixtures of THF/p-xylene. These studies indicate that the combination of field modulation spectrometry, with conductance studies can give valuable information concerning the nature and dynamics of electrolyte aggregates in low dielectric media. In addition, the effect of solvent structure upon the distribution of species can be determined.

30063 (SERI/CP—234-1577, pp 185-206) **Electrochemical studies of Fe(II) and Fe(III) in an aluminum chloride-butylpyridinium chloride ionic liquid.** Nanjundiah, C.; Shimizu, K.; Osteryoung, R.A. (State Univ. of New York, Buffalo). 1981. NTIS, PC A11/MF A01.

From Thermo regenerative electrochemical systems workshop; Alexandria, VA, USA (3 Dec 1981).

Electrochemical studies of Fe(II) and Fe(III) have been carried out in $AlCl_3$:N-Butylpyridinium chloride (BuPyCl) ionic liquid at 40°C as a function of melt composition. Analysis of measurements in the basic (excess BuPyCl) melt indicate $FeCl_4^-$ and $FeCl_4^{2-}$ as the dominant species. Rotating disc electrode measurements indicate that the Fe(II) oxidation is reversible in the basic melt; the Fe(II)-Fe(III) electron transfer process becomes irreversible in acidic systems. Viscosity and density measurements as a function of melt composition were made to permit evaluation of marked changes in limiting currents at the rotating glassy carbon disc electrode. It is shown that the Stokes-Einstein equation is obeyed.

30064 **Optimization of explicit finite-difference simulation of electrochemical phenomena utilizing an exponentially expanded space grid: refinement of the Joslin-Pletcher algorithm.** Feldberg, S.W. (Brookhaven National Lab., Upton, NY). *Journal of Electroanalytical Chemistry;* **127**: 1-10(1981). Contract AC02-76CH00016.

Digital simulation of electrochemical phenomena using an exponentially expanding space grid, as suggested by Joslin and Pletcher, can offer significantly more rapid computation for a given analysis than can be obtained with the conventional uniform space grid. (In a uniform grid the thicknesses of the volume elements, Δx_i, are the same; in the exponentially expanding space grid $\Delta x_{i+1}/\Delta x_i$ is a constant, greater than unity and as large as $e^{0.5}$.) Unfortunately, the Joslin-Pletcher algorithms introduce some small errors (~ 1%) into the flux computations. In the present work, it will be shown that a slightly different analysis leads to algorithms that are considerably more accurate (< 0.1% error) yet do not compromise the simplicity of the explicit finite-difference method or the enhanced speed of the Joslin-Pletcher approach. 2 figures, 1 table.

4005 Photochemistry

REFER ALSO TO CITATION(S) 30041, 30053, 30055, 30060, 30076, 30080

30065 **Photochemistry of benzene and oxygen in supersonic cluster beams.** Knee, J.L.; Otis, C.E.; Johnson, P.M. (State Univ. of New York, Stony Brook). *Journal of Physical Chemistry;* **86**: No. 23, 4467-4469(11 Nov 1982). Contract AC02-80ER10660.

A reaction is seen to occur between benzene and oxygen in a supersonic beam when mixed clusters are irradiated by 193nm. This reaction has been investigated by multiphoton ionization mass spectrometry, with primary reaction products including the introduction of up to four oxygen atoms onto the benzene, as well as species resulting from hydrogen abstraction. A two laser experiment indicates that the initial step in the photochemical reaction results in a neutral species which lives for longer than 100 μs.

30066 **Photooxidation of formaldehyde in solid oxygen and argon/oxygen matrices at 12 K.** Diem, M.; Lee, E.K.C. (Univ. of California, Irvine). *Journal of Physical Chemistry;* **86**: No. 23, 4507-4512(11 Nov 1982).

Matrix-isolated formaldehyde in solid O_2, Ar/O_2, and Ar matrices at 12 K has been photolyzed by ultraviolet light in the 220-400-nm range. The photoproducts were identified by infrared spectroscopy. Stable oxidation products were CO, CO_2, H_2O, H_2O_2, O_3, and HCOOH, whereas relatively unstable products were HO_2, its hydrogen-bonded dimer $(HO_2)_2$, formylperoxy radical HC(O)OO, and performic acid. The observed photoproduct distribution is rationalized by the stoichiometry of chemical reactions involving one C atom, two H atoms, and odd numbers of O atoms in the cage. Photolysis of the $Ar/O_2/H_2CO$ sample (10% O_2 in solid Ar) gave poor yields of radical species. Under the experimental conditions employed, the photochemical oxidation process is not driven to completion, and therefore it is possible to trap reactive intermediates for spectroscopic and kinetic studies. Photodissociation thresholds of H_2CO and $(H_2CO)_2$ in solid Ar have been measured with tunable, pulsed UV laser photolysis to show that $(H_2CO)_2$ has a lower threshold than H_2CO.

30067 **Excited-state redox properties of ruthenium(II) phthalocyanine from electron-transfer quenching.** Prasad, D.R.; Ferraudi, G. (Univ. of Notre Dame, IN). *Journal of Physical Chemistry;* **86**: No. 20, 4037-4040(30 Sep 1982).

Electron-transfer reactions between the lowest-lying triplet state, $^3\pi\pi^*$, of ruthenium (phthalocyanine)(pyridine)$_2$ and various nitroaromatic compounds have been studied by laser and conventional flash photolysis. Quenching rate constants determined for the oxidation of the excited state have been treated according to the Marcus-Hush theory. A self-exchange rate constant $K \sim 10^7$ $M^{-1} x^{-1}$ was determined for the self-exchange reaction between the $^3\pi\pi^*$ and radical cation, $Ru(ph)(py)_2^+$. Such a value indicates that the major component to the Franck-Condon reorganizational energy is the outer-sphere contribution. The photochemical properties of the phthalocyanines are discussed in terms of the redox potentials estimate for various excited states.

30068 **Partitioning of excess energy in the photolysis of cyanogen chloride and cyanogen bromide at 193 nm.** Halpern, J.B.; Jackson, W.M. (Howard Univ., Washington, DC). *Journal of Physical Chemistry;* **86**: No. 18, 3528-3533(2 Sep 1982).

The nascent quantum state distributions of $CN(X^2\Sigma^+)$ fragments produced in the dissociation of ClCN and BrCN by photolysis at 193 nm, in an effusive beam, have been measured. The rotational distribution of the fragments is highly excited. The results show that the excited electronic state which dissociates is bent. A simple parameterization is shown to fit the results. This parametrization is based on a semiclassical model which has dynamical implications. 9 figures, 1 table.

30069 **Photoionization of the Kr_2 dimer.** Pratt, S.T.; Dehmer, P.M. (Argonne National Lab., IL). *Chemical Physics Letters;* **87**: No. 6, 533-538(16 Apr 1982).

The relative photoionization cross section of Kr_2 was determined from 900 to 970 A at a resolution of 0.15 A. Complex molecular autoionization structure is observed throughout the spectrum and has been analyzed in part in terms of Rydberg states converging to the $A^2\Sigma_{1/2u}^+$ and $B^2\pi_{3/2g}$ states of the ion.

30070 **Visible light photolysis of tris(bipyridine)ruthenium(II)-titanium(II) solutions.** Brunschwig, B.S.; Sutin, N. (Brookhaven National Lab., Upton, NY). *Chemical Physics Letters;* **77**: No. 1, 63-65(1 Jan 1981).

Hydrochloric acid solutions containing tris(bipyridine)ruthenium(II) and titanium(III) were irradiated with visible light. Contrary to a published report, virtually no molecular hydrogen was found to be produced during the photolysis (quantum yield $\leq 10^{-5}$ mol einstein^{-1}. The mechanism of the quenching of the charge-transfer excited state of the ruthenium(II) complex by titanium(III) is discussed.

30071 **Vibrational effects in the shape-resonant photoionisation of CO_2.** Swanson, J.R. (Boston Univ., MA); Dill, D.; Dehmer, J.L. *Journal of Physics B: Atomic and Molecular Physics;* **14**: L207-L211(1981).

Multiple scattering model calculations of vibrationally averaged asymmetry parameters (β) for the $1\pi_g$, $1\pi_u$, $3\sigma_u$ and $4\sigma_g$ levels of CO_2 are compared to fixed-nuclei calculations. Vibrational branching ratios and vibrationally resolved asymmetry parameters β_v for the $1\pi_g$ and $1\pi_u$ levels are also presented. The latter are compared to recent He I line source measurements. The resonant features of the vibrationally averaged β are less pronounced than those calculated with fixed nuclei, while the resolved spectra show shape-resonant features which are not apparent in the unresolved spectra. 3 figures, 1 table.

30072 **Resonance ionization spectroscopy.** Hurst, G. (Oak Ridge National Lab., TN). *Analytical Chemistry;* **53**: vp(1981). Contract W-7405-ENG-26.

The article summarizes the history of resonance ionization spectroscopy (RIS) and its growing potential as a tool in physics and analytical chemistry. The use of RIS is classified in these respects: (1) basic ways of counting atoms; (2) use determined by the type of particle detector; (3) classification of RIS applications according to source preparation; (4) uses in physics and chemistry; (5) use in the neutralization of daughter atoms. Research programs are underway to find useful combinations of RIS technology with mass spectroscopy, and with accelerators. 2 figures, 4 tables.

4006 Radiation Chemistry

REFER ALSO TO CITATION(S) 29974, 29975, 30021

30073 (ANL—82-65-Pt.2, pp 68-89) **Analytic development of the track structure of electrons in water.** Pagnamenta, A. (Univ. of Chicago, IL); Marshall, J.H. Nov 1982. NTIS, PC A11/MF A01.

In Radiological and Environmental Research Division, Center for Human Radiobiology. Annual report, July 1981-June 1982.

Growing knowledge about the size of biological model parameters for the initiation of cancer by radiation makes it of current interest to study physical influence parameters beyond dose and LET (Linear Energy Transfer), such as the detailed distribution of ionizations along an electron track. We have refined our earlier calculation of the electron track structure by deriving expressions for the ionization cross section and the LET, which give results in excellent agreement with all the available data on differential and integrated ionization cross sections, LET and energy per ion-pair. The result is a reliable expression for the distribtion of ionizations along the main track of a beta ray, as well as on the resulting delta rays up to fourth order.

30074 **(CONF-811278—1) Radiolytic oxidation of technetium dioxide.** Nash, K.L.; Fried, S.; Friedman, A.M. (Argonne National Lab., IL (USA)). 1981. Contract W-31-109-ENG-38. 6p. NTIS, PC A02/MF A01. Order Number DE83010631.

From Subseabed disposal program annual meeting; Denver, CO, USA (27 Dec 1981).

Samples of the insoluble technetium dioxide (TcO_2) were slurried in distilled water and in seawater and allowed to oxidize under the influence of their own radiation $^{99}Tc \rightarrow {}^{99}Ru$ (0.293 keV beta decay). Under these conditions only about 10 to 15% of the Tc was oxidized. When the technetium solutions were subjected to greater radiation fields by addition of ^{244}Cm the oxidation of the technetium to pertechnetate was virtually complete. In the case of TcO_2 slurries without added radioactivity it was found that the concentration of pertechnetate ion, TcO_4, reached a maximum and then declined to about one-half of that maximum value. The practical significance of these results is that technetium does exist in the oxidized form (as soluble pertechenetate) in a radiation field. Repository design, therefore, must include a backfill material which will adsorb or reduce the TcO_4^- anion to ensure its isolation from the surrounding environment. 1 figure, 1 table.

30075 **(CONF-8111143—1) Time-resolved pulsed EPR: microwave and optical detection.** Trifunac, A.D.; Smith, J.P. (Argonne National Lab., IL (USA)). 1981. Contract W-31-109-ENG-38. 16p. NTIS, PC A02/MF A01. Order Number DE83007853.

From Autumn school on modern methods in high frequency spectroscopy; Reinhardsbrunn, German Democratic Republic (2 Nov 1981).

Portions are illegible in microfiche products.

Time-resolved pulsed EPR spectrometers are described. EPR spectra, kinetic profiles, and relaxation studies are used to illustrate some capabilities of the pulsed EPR experiment. Optical detection of time-resolved EPR spectra of radical ion pairs is used to study radical-ion recombination kinetics, recombination pathways, and the structure of radical anions and cations. 17 figures.

30076 **(DOE/ET/00038—2454) Radiation Laboratory quarterly report, January 1-March 31, 1983.** (Notre Dame Univ., IN (USA). Radiation Lab.). 4 Apr 1983. Contract AC02-76ER00038. 63p. (NDRL—2454). NTIS, PC A04/MF A01. Order Number DE83010648.

Short summaries of 40 research programs in progress and abstracts of 44 reports submitted for publication are presented. These are in the fields of radiation chemistry and photochemistry. (ATT)

30077 **Nuclear magnetic resonance detected nuclear resonance of transient radicals.** Nuttall, R.H.D.; Trifunac, A.D. (Argonne National Lab., IL). *Journal of Physical Chemistry;* **86**: No. 20, 3963-3969(30 Sep 1982).

Nuclear resonances in transient radicals produced in liquids by pulse radiolysis have been detected by using NMR of their reaction products. The NMR intensities are affected by application of rf corresponding to nuclear resonances of the radical intermediates. NMR-detected nuclear resonance (NMR-NR) spectra for several chemical systems are presented. Information from these spectra about relative populations of the radical magnetic energy levels is explained with the radical pair theory of chemically induced magnetic polarization, both electron (CIDEP) and nuclear (CIDNP). For some systems, weak lines in the NMR-NR spectra have been assigned as due to double quantum transitions between energy levels differing by two in nuclear spin quantum number.

30078 **Spectroscopic studies of α-induced radiation damage in divalent metal fluorides.** Exarhos, G.J. (Pacific Northwest Lab., Richland, WA). *Journal of Physical Chemistry;* **86**: No. 20, 4020-4025(30 Sep 1982). Contract AC06-76RL01830.

Single-crystal alkaline earth fluorides were subjected to 5.5-MeV α irradiation from an external $^{238}PuO_2$ source and the induced localized defects were identified by means of optical absorption and vibrational Raman spectroscopy. Vibrational modes intrinsic to F-center and interstitial defects were observed and the existence of the F_2^- species was confirmed. Damage ingrowth and annealing studies indicate the applicability of the first-order kinetic processes in describing these phenomena and the activation energy for F-center recombination was found to be 0.20 eV. The nature of the damage source on induced defects is discussed.

30079 **Thermally induced free-radical reactions in α-D-glucopyranose single crystals. An electron spin resonance-electron nuclear double resonance study.** Madden, K.P.; Bernhard, W.A. (Univ. of Rochester, NY). *Journal of Physical Chemistry;* **86**: No. 20, 4033-4036(30 Sep 1982). Contract AC02-76EV03490.

The dominant radical in single crystals of anhydrous α-D-glucopyranose X-irradiated at 77 K, a C6 primary hydroxyalkyl radical, reorients slightly upon warming to ~ 200 K and converts to a C2 primary hydroxyalkyl radical upon warming to ~ 300 K. Annealing the sample at room temperature overnight results in several free-radical products, one identified as a C2 secondary hydroxyalkyl radical. The mechanisms of the free-radical reactions are discussed and compared to those postulated by using data from end-product analysis of irradiated crystalline α-D-glucose.

30080 **Electron attachment to p-benzoquinone and photodetachment from benzoquinone anion in nonpolar solvents.** Holroyd, R.A. (Brookhaven National Lab., Upton, NY). *Journal of Physical Chemistry;* **86**: No. 18, 3541-3547(2 Sep 1982).

Although p-benzoquinone has a high electron affinity (1.9 eV), its reaction with excess electrons exhibits an unusual solvent and temperature dependence. The reaction is fast and has a positive activation energy in n-pentane but is much slower and has a negative activation energy in $Si(CH_3)_4$, neopentane, and 2,2,4,4-tetramethylpentane. The results can be explained in terms of an equilibrium with a short-lived excited state of the anion: e^- + benzoquinone reversible benzoquinone(-)*. The attachment rate is fast in all solvents. The reverse, autodetachment from the excited anion, is characterized by an activation energy, which depends on the value of V_0, the energy level of the electron in the liquid. For $Si(CH_3)_4$ for which V_0 is the lowest (-0.55 eV), the activation energy is 5.7 kcal/mol. As V_0 increases, the activation energy increases and is 9.4 kcal/mol in 2,2,4,4-tetramethylpentane for which V_0 = -0.35 eV. When V_0 is close to zero, as in n-pentane, the activation energy is so large that detachment from the excited anion state is too slow to compete with deactivation and a fast diffusion-controlled forward rate is observed. The spectrum of benzoquinone anion as observed by the laser photodetachment technique is reported, and the threshold for photodetachment is found to be 2.32 eV in $Si(CH_3)_4$ and 2.58 eV in 2,2,4-trimethylpentane. The quantum yield of photodetachment reaches a maximum value at 480 nm in $Si(CH_3)_4$. 6 figures, 2 tables.

30081 **One-electron redox potentials of phenols. Hydroxy- and aminophenols and related compounds of biological interest.** Steenken, S. (Max-Planck-Institut fur Strahlenchemie, Muelheim, West Germany); Neta, P. *Journal of Physical Chemistry;* **86**: No. 18, 3661-3667(2 Sep 1982).

The rate constants for reversible electron transfer between a series of substituted phenolate ions and anilines and various substituted phenoxyl or anilino radicals in aqueous solution were measured by observing the formation or depletion of the radicals involved. Nonequilibrium concentrations of the radicals were pro-

duced in the presence of the corresponding phenols or anilines by using the pulse radiolysis technique. The relaxation of the system to equilibrium was monitored by optical detection methods. From the equilibrium constants for one-electron transfer, the one-electron redox potentials (E^2) for 38 phenolic or anilino type compounds were determined, many of which are natural products. The redox potentials are strongly influenced by electron-donating or -withdrawing substituents at the aromatic system. 3 figures, 5 tables.

30082 **Resonance Raman spectra of galvinoxyl free radical.** Tripathi, G.N.R. (Univ. of Notre Dame, IN). *Chemical Physics Letters;* **81**: No. 2, 375-379(15 Jul 1981).

Reported are Raman spectra of the galvinoxyl free radical in the resonance and preresonance regions. A tentative vibrational assignment has been proposed. The resonance Raman spectrum of galvinoxyl as low as $\sim 10^{-7}$ M is obtainable. The possibility of using galvinoxyl Raman bands as a probe for radical scavenging in pulse radiolysis and flash photolysis is discussed.

30083 **Redox properties of free radicals.** Neta, P. (Univ. of Notre Dame, IN). *Journal of Chemical Education;* **58**: No. 2, 110-113(Feb 1981).

Results of electron transfer reactions observed and monitored by pulse radiolysis are reported. This technique allows determination of the first one-electron reduction or oxidation of a compound rather than the overall two-electron transfer usually reported. Pulse radiolysis allows the determination of absolute rate constants for reactions of free radicals and helps elucidate the mechanisms involved. Studies using this technique to study radicals derived from quinones, nitro compounds, pyridines, phenols, and anilines are reported. Radicals of biochemical interest arising from riboflavin, ascorbic acid, vitamin K_3, vitamin E, MAD^+, porphyrins, etc. have also been studied. (BLM)

4007 Radiochemistry And Nuclear Chemistry

REFER ALSO TO CITATION(S) 29174, 29175, 30017, 30448, 30807

30084 **(AAEC/E—543) Validation of the sterile manufacture of the AAEC MARK III molybdenum-99/techtnetium-99m generator.** Saunders, M.T.; Drummond, C.M.; Harrison, M.A. (Australian Atomic Energy Commission Research Establishment, Lucas Heights). Jul 1982. 20p. NTIS (US Sales Only), PC A02/MF A01. Order Number DE83700482.

The Mark II molybdenum-99/technetium-99m generator now supplied to hospitals by the Australian Atomic Energy Commission is a non-sterile elution system. The Mark III version will be supplied as a sterile elution system. A validation study has been undertaken to assess the capability of the new production facility, to evaluate up-to-date procedures for manufacturing sterile generators and to demonstrate that a sterile radionuclide generator can be made. Generator manufacturing procedures and a time study of the validation are described. Microbiological methods for monitoring in-process aspects of manufacture, disinfectant efficacy and generator sterility are defined.

30085 (ANL—82-65-Pt.2, pp 111-124) **Rare earth aerosol analysis by atomic absorption spectrophotometry using electrothermal atomization.** Citron, I.M.; Holtzman, R.B. Nov 1982. NTIS, PC A11/MF A01.

In Radiological and Environmental Research Division, Center for Human Radiobiology. Annual report, July 1981-June 1982.

Atomic absorption spectrophotometry (AAS) employing electrothermal atomization in a pyrolytic graphite tube is shown to be a precise and accurate method for analysis of 11 rare earth, or rare-earth-like elements in air filter samples taken in a thorium and rare earth refinery. The method is fairly rapid since it involves only fluoric acids. Each element was sequentially analyzed from the same resulting solution by using either the techniques of standard-curve calibration or that of standard additions. The two methods used on the same sample gave essentially identical results (composite ratio for 171 such trials being 0.9996). Matrix effects were negligible and no background correction was necessary. The average percent standard deviation for all duplicate trials (176) was 4.2%. Elements analyzed by this method were La, Nd, Sm, Eu, Gd, Dy, Ho, Tm, Yb, Gd, Sc and Y. Other rare earths such as erbium (Er), lutetium (Lu), and terbium (Tb), with comparable analytical sensitivity by AAS to Dy, Sm, and Nd, respectively, could presumably be analyzed by this method as well.

30086 (ANL—82-65-Pt.2, pp 125-138) **Rare earth analysis in human biological samples by atomic absorption using electrothermal atomization.** Citron, I.M.; Holtzman, R.B.; Leiman, J. Nov 1982. NTIS, PC A11/MF A01.

In Radiological and Environmental Research Division, Center for Human Radiobiology. Annual report, July 1981-June 1982.

The determination of Sc and seven rare earth elements, Nd, Sm, Dy, Ho, Eu, Tm, and Yb, in biological samplesby atomic absorption spectrophotometric analysis (AAS) using electrothermal atomization in a pyrolytic graphite tube is shown to be rapid, precise and accurate. The technique utilizes the method of standard additions and linear regression analysis to determine results from peak area data. Inter-elemental interferences are negligible. The elements found sensitive enough for this type of analysis are, in order of decreasing sensitivity, Yb, Eu, Tm, Dy, Sc, Ho, Sm and Nd. The determination in these types of materials of Gd and elements less sensitive to AAS detection than Gd does not appear to be feasible. Results are presented on the concentrations of these elements in 41 samples from human subjects, cows and vegetables with normal environmental exposure to the rare earth elements. The composite percent mean deviation in peak-area readings for all samples and all elements examined was 4%. The mean standard error in the results among samples was about 6.5%.

30087 (LA—9479-PR, pp 117-118) **Organic synthesis with stable isotopes.** Blazer, R.M.; Daub, G.H.; Kerr, V.N.; Williams, D.L.; Whaley, T.W. Oct 1982. NTIS, PC A08/MF A01.

In Los Alamos Life Sciences Division's biomedical and environmental research programs. Progress report, January-December 1981.

Described is a scheme for the synthesis of L-arginine-1-^{13}C utilizing methods developed for the synthesis of L-ornithine-1-^{13}C from L-ornithine-2-^{13}C and then converting ornithine into arginine with the enzyme acylase. (DLS)

30088 (LA—9479-PR, pp 119-120) **Asymmetric syntheses of amino acids.** Blazer, R.M.; Daub, G.H.; Williams, D.L.; Whaley, T.W. Oct 1982. NTIS, PC A08/MF A01.

In Los Alamos Life Sciences Division's biomedical and environmental research programs. Progress report, January-December 1981.

Two approaches to the problem of asymmetric syntheses of amino acids are described: chiral hydrogenation reactions and chiral alkylation reactions. The first approach was illustrated by the synthesis of L-tryptophan-1-^{13}C, and the second by the alkylation of a chiral glycine-iminoester. (ACR)

30089 **(NP—3901799) Study of plutonium in nitrate systems.** Steinhauser, M. (Muenchen Univ. (Germany, F.R.)). 1981. 90p. (In German). NTIS (US Sales Only), PC A05/MF A01. Order Number DE83901799.

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A study is made of Pu(VI) in nitric acid for the purpose of stoichiometrically defining plutonium as a starting material for making fuel elements, using both simple and complex carbonates and nitrates. Absorption spectra of Pu solution are graphed, and the apparatus employed for the study of plutonium oxide solutions is illustrated. 43 references, 30 figures.

30090 **The synthesis and characterization of neptunium hydroxysulfate, $Np(OH)_2SO_4$.** Wester, D.W.; Mulak, J.; Banks, R.; Carnall, W.T. (Argonne National Lab., IL). *Journal of Solid State Chemistry;* **45**: No. 2, 235-240(15 Nov 1982).

Neptunium (IV) hydroxysulfate, $Np(OH)_2SO_4$, was synthesized using hydrothermal techniques. The X-ray powder diffraction pattern indicates that the compound is isomorphous with the

Th(IV) and U(IV) analogs. Cell constants for the three compounds clearly show the effects of the actinide contraction. Visible and near-ir spectra are consistent with the presence of Np(IV) and are compared to spectra of Np(IV) in acidic solution. The ir spectrum contains bands which are assigned to the hydroxy and sulfate groups.

30091 **Preparation of multitritiated arenes.** Cacace, F. (Rome Univ. (Italy)); Speranza, M. (Consiglio Nazionale delle Ricerche, Rome (Italy). Lab. di Chimica Nucleare); Wolf, A.P. (Brookhaven National Lab., Upton, NY (USA)); Ehrenkaufer, R. (Michigan Univ. Hospital, Ann Arbor (USA)). *Journal of Labelled Compounds and Radiopharmaceuticals;* **19**: No. 8, 905-914(Aug 1982).

The decay technique, currently applied to the study of ionic processes in gaseous and liquid systems, requires multitritiated precursors to generate labeled daughter ions. The preparation of three such precursors, namely $C_6{}^3$Hsub(x)Hsub(6-x), $C_6{}^3$Hsub(x)Hsub(5-x)CH_3, and $C_6H_5C{}^3$Hsub(x)Hsub(3-x) is described.

30092 **Aromatic fluorinations suitable for fluorine-18 labeling of estrogens.** Ng, J.S.; Katzenellenbogen, J.A.; Kilbourn, M.R. (Univ. of Illinois, Urbana). *Journal of Organic Chemistry;* **46**: 2520-2528(1981).

Two aromatic fluorination methods, the decomposition of aryl azides and the decomposition of aryltriazenes, were investigated as methods potentially suitable for fluorine-18 labeling of estrogens. The aryltriazene method gives moderate yields in many systems but fails with o-methoxy or (methanesulfonyl)osy groups. The aryl azide method gives good yields of p-fluoroanilines, which can be deaminated readily, but oxygen or large alkyl groups ortho to the azide interfere with the fluorination. The synthesis of m-fluorohexestrol via the aryltriazene decomposition approach is reported.

30093 **Production of transplutonium elements in the high flux isotope reactor.** Bigelow, J.E.; Corbett, B.L.; King, L.J.; McGuire, S.C.; Sims, T.M. (Oak Ridge National Lab., TN). *ACS Symposium Series;* No. 161, 3-18(1981). Contract W-7405-ENG-26.

The techniques described here have been demonstrated to predict the contents of transplutonium element production targets, at least for isotopes of mass 253 or less. The HFIR irradiation model is a workhorse for planning the TRU processing campaigns, for certifying the heat evolution rate of targets prior to insertion in the reactor, for predicting future production capabilities over a multi-year period, and for making optimization studies. Practical considerations, however, may limit the range of available options so that optimum operation is not always achievable. We do intend, however, to keep fine-tuning the constants which define the cross sections as time permits. We need to do more work on optimizing the production of ^{250}Cm, ^{254}Es, ^{255}Es, and ultimately ^{257}Fm, since researchers are interested in obtaining larger quantities of these rare and difficult-to-produce nuclides. 7 figures, 2 tables.

30094 **Actinide 5f systems: experimental determination of the magnetic response function.** Lander, G.H. (Argonne National Lab., IL). pp 215-227 of Crystalline electric field and structural effects in f-electron systems. Crow, J.E.; Guertin, R.P.; Mihalisin, T.W. (eds.). New York, NY; Plenum Publishing Corporation (1980).

Neutron cross section has been discussed at some length, and it is pointed out that more than just cf levels can be seen with neutron spectroscopy. Measurements are reported for the non-ordered system $U_{0.15}Th_{0.85}Se$ and other diluted U systems. Measurements are presented for the ordered systems, UN, UAs, and USb. It is evident from the neutron spectroscopic studies that many of the U compounds show characteristics of intermediate valences. 26 references. (BLM)

4008 Combustion, Pyrolysis, And High-temperature Chemistry

REFER ALSO TO CITATION(S) 28969, 30153, 30154, 30155, 30156, 30157, 30158, 30159, 30160, 30161, 30162, 30163, 30164

30095 **(LA-UR—83-875) Introduction to multidimensional combustion modeling with the CONCHAS-SPRAY computer program.** O'Rourke, P.J. (Los Alamos National Lab., NM (USA)). 1982. Contract W-7405-ENG-36. 32p. (CONF-821231—1). NTIS, PC A03/MF A01. Order Number DE83009886.

From Workshop on nonlinear problems in applied combustion; Rocquencourt, France (7 Dec 1982).

CONCHAS-SPRAY is a finite-difference computer code for the calculation of two-dimensional chemically reacting fluid flows. In this paper we discuss four problem areas that are encountered in multidimensional numerical combustion modeling, and the numerical techniques used by CONCHAS-SPRAY to overcome these problems. Then the equations are given that are solved by the computer code, and some results from an example problem are discussed. 7 figures, 1 table.

42 ENGINEERING

4202 Facilities And Equipment

REFER ALSO TO CITATION(S) 28898, 28899, 28912, 28929, 28930, 28931, 28932, 28933, 28934, 28936, 28951, 28952, 28953, 28954, 29068, 29115, 29116, 29423, 29558, 29897, 30137, 30141, 30205, 30239, 30303, 30305, 30897, 30902, 30970

30096 (ANL—82-80, pp 339-355) **Remote handling equipment for SNS.** Poulten, B.H. (Rutherford Appleton Lab., Chilton, England). Jan 1983. NTIS, PC A99/MF A01.

From 6. annual international collaboration of advanced neutron sources meeting; Argonne, IL, USA (28 Jun 1982).

This report gives information on the areas of the SNS, facility which become highly radioactive preventing hands-on maintenance. Levels of activity are sufficiently high in the Target Station Area of the SNS, especially under fault conditions, to warrant reactor technology to be used in the design of the water, drainage and ventilation systems. These problems, together with the type of remote handling equipment required in the SNS, are discussed.

30097 **(BDX—613-2924) Cactus.** Sexton, R.L. (Bendix Corp., Kansas City, MO (USA)). Mar 1983. Contract AC04-76DP00613. 60p. NTIS, PC A04/MF A01. Order Number DE83010519.

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The CACTUS project (computer-aided control, tracking, and updating system) was initiated by the Bendix Kansas City Division to address specific work-in-process problems encountered in a cable department. Since then, the project has been expanded to additional electrical manufacturing departments because of potential productivity gains from the system. The philosophy of CACTUS is to add an element of distributed data proessing to the centralized data processing system currently in use for control of work in process. Under this system, the existing chain of communications between the host computer and the CRT terminals in a department is severed. A mini-computer established in the department communicates directly with the central system, and departmental communication is then established with the mini-computer. The advantages, disadvantages, operation performance, and economics of the system are discussed.

30098 **(CONF-800804—45) Acoustic loading effects on oscillating rod bundles.** Lin, W.H. (Argonne National Lab., IL (USA)). 1980. Contract W-31-109-ENG-38. 6p. NTIS, PC A02/MF A01. Order Number DE83010278.

From ASME century 2 emerging technology conference; San Francisco, CA, USA (10 Aug 1980).

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An analytical study of the interaction between an infinite acoustic medium and a cluster of circular rods is described. The acoustic field due to oscillating rods and the acoustic loading on the rods are first solved in a closed form. The acoustic loading is then used as a forcing function for rod responses, and the acousto-elastic couplings are solved simultaneously. Numerical examples are presented for several cases to illustrate the effects of various system parameters on the acoustic reaction force coefficients. The effect of the acoustic loading on the coupled eigenfrequencies are discussed.

30099 **(DOE/ER/03077—180) Analysis of three-dimensional transonic compressors.** Bourgeade, A. (New York Univ., NY (USA). Courant Inst. of Mathematical Sciences). Feb 1983. Contract AC02-76ER03077. 110p. NTIS, PC A06/MF A01. Order Number DE83009537.

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This presentation sets forth a method for computing the three-dimensional transonic flow around the blades of a compressor or of a propeller. The method is based on the use of the velociy potential, on the hypothesis that the flow is inviscid, irrotational and isentropic. The equation of the potential is solved in a transformed space such that the surface of the blade is mapped into a plane where the periodicity is implicit. This equation is in a non-conservative form and is solved with the help of a finite difference method using artificial viscosity and artificial time. A computer code is provided and some sample results are given in order to demonstrate the influence of three-dimensional effects and the blade's rotation.

30100 **(DOE/NBM—3010569) Continuous-diffusion crossover-system design.** Meng, S.Y.; Jackson, E.D. (Rockwell International Corp., Canoga Park, CA (USA). Rocketdyne Div.). 12 Oct 1982. Contract W-31-109-ENG-38. 48p. NTIS, PC A03/MF A01. Order Number DE83010569.

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The continuous-diffusion crossover system serves as a connecting passage and diffuser between two centrifugal impeller stages. This system consists of identical continuous passages axisymmetrically distributed on a disk plane. Every individual passage consists of two straight meanline diffusers with a turning channel in between. The advantage of this system is reduced diameter for large velocity reduction with reduced pressure loss. The straight meanline diffuser has an extensive published experimental base to enable prediction of diffuser performance with a high confidence of success, and it provides a uniform impeller inlet velocity profile resulting in good impeller performance. This report brings together numerous published experimental results and shows how these can be used together with relatively simple analytical approaches to achieve a high diffuser-crossover system performance. Design details that enhance the performance are discussed. Also, a stall model developed to handle the prediction of the occurrence of stall and the accompanying head loss due to the diffuser inlet is presented. This model has been shown to correlate well with experimental data. The model can be successfully applied to any vane system, rotating or stationary, to predict the off-design flow that will cause the vane inlet to stall.

30101 **(JAERI-M—9562) Shielding analysis on spent fuel transport cask by RADHEAT-V3 code system.** Kamiya, M.; Yamano, N.; Shimooke, T. (Japan Atomic Energy Research Inst., Tokyo). Jul 1981. 48p. (In Japanese). NTIS (US Sales Only), PC A03/MF A01. Order Number DE83701537.

Shielding analysis on spent fuel transport cask has been performed by using PADHEAT-V3 code system. A typical model of PWR spent fuel transport cask is used in this study. Analyses are performed from the estimations of neutron and γ-ray sources to two-dimensional S sub(N)-transport calculations so as to assess quantitatively the effects of various calculational parameters. Streaming and secondary gamma-ray effects in the spent fuel cask are also discussed. It is concluded that the RADHEAT-V3 code system is throughly applicable for shielding safety analysis on spent fuel transport cask.

30102 **(LA-UR—83-601) Progress in uv damage testing at Los Alamos.** Foltyn, S.R.; Jolin, L.J.; Newnman, B.E. (Los Alamos National Lab., NM (USA)). 1982. Contract W-7405-ENG-36. 9p. (CONF-821170—2). NTIS, PC A02/MF A01. Order Number DE83009940.

From Conference on laser induced damage in optical materials; Boulder, CO, USA (15 Nov 1982).

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A laser damage test facility is described which employs in-line beam diagnostics and a real-time video monitoring system. Testing at three excimer laser wavelengths is accomplished at 35 pps with a nominal 10-ns pulsewidth. The test spotsize ($1/e^2$ diameter) is typically 0.6 mm. Samples have consisted primarily of multilayer dielectric reflectors composed of a variety of materials. In particular, the best results - is congruent to 3 J/cm² at 248 nm, is congruent to 5 J/cm² at 308 nM, and is congruent to 8 J/cm² at 351 nm - have been obtained consistently for coatings utilizing ThF_4, Al_2O_3, or Sc_2O_3 as the high-index component. Significant improvement has resulted from the use of non-quarterwave designs at 248 and 308 nm. Also presented are preliminary 248 nm test results for LiF - both single crystal and press-forged - and KD*P.

30103 **(LA-UR—83-804) Use of lasers at the Los Alamos Hot-Cell Facility.** Lazarus, M.E. (Los Alamos National Lab., NM (USA)). 1983. Contract W-7405-ENG-36. 8p. (CONF-830425—7). NTIS, PC A02/MF A01. Order Number DE83010087.

From Society of Photo-Optical Instrumentation Engineers conference; Santa Fe, NM, USA (11 Apr 1983).

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An optical profilometer that uses a Techmet LaserMike scanning, focused, laser-beam, optical micrometer is installed in a remote alpha-gamma containment cell at the Los Alamos Hot-Cell Facility. A hot-cell extension chamber provides the nominal 30-cm (12-in.) working distance required by the LaserMike and, at the same time, keeps the LaserMike components outside the high-radiation-containment environment. This system provides measurement accuracy better than +- 5 μm (0.0002 in.) on diameters between 2 and 13 mm (0.88 and 0.5 in.) at a rate of 33 measurements per second. The Hot-Cell Facility also uses a Korad 20-J-output ruby pulsed laser to drill a hole in reactor-fuel-element cladding to sample fission gas. The laser is then used to reweld the hole so that the fuel element will not be contaminated and may be stored without an alpha-containment barrier. The wall thickness of the fuel elements sampled varies from 0.25 to 0.50 mm (0.010 to 0.020 in.).

30104 **(LA-UR—83-810) Streak camera aperature function.** Dunbar, D.L. (Los Alamos National Lab., NM (USA)). 1983. Contract W-7405-ENG-36. 7p. (CONF-830425—6). NTIS, PC A02/MF A01. Order Number DE83010088.

From Society of Photo-Optical Instrumentation Engineers conference; Santa Fe, NM, USA (11 Apr 1983).

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This paper derives the temporal bandwidth of a multichannel streak camera from scanning and Fourier theories. It first describes what a multichannel streak-camera system is and then models the camera through the use of a transformation from the spatial to time domain. The image on the photocathode surface is transformed mathematically to the phosphor through the use of a convolution of the image and a moving aperture. The resulting image on the phosphor then becomes a function of both space and time. A Fourier transform of this function gives both a spatial and temporal bandwidth of the tube. From the model it can be shown how to properly use the tube to obtain temporal data.

30105 **(LA-UR—83-953) Optical engineering at Los Alamos: a history.** Brixner, B. (Los Alamos National Lab., NM (USA)). 1983. 16p. (CONF-830425—3). NTIS, PC A02/MF A01. Order Number DE83009905.

From Society of Photo-Optical Instrumentation Engineers conference; Santa Fe, NM, USA (11 Apr 1983).

Optical engineering at Los Alamos, which began in 1943, has continued because scientific researchers usually want more resolving power than commercially available optical instruments provide. In addition, in-house engineering is often advantageous -

when the technology for designing and making improved instrumentation is available locally - because of our remote location and the frequent need for accurate data. As a consequence, a number of improved research cameras and lens systems have been developed locally - especially for explosion and implosion photography, but even for oscilloscope photography. The development of high-speed cameras led to the ultimate in practical high-speed rotating mirrors and to the invention of a rapid, precise, and effective lens design procedure that has produced more than a hundred lens system that gives improved imaging in special conditions of use. Representative examples of this work are described.

30106 **(UCID—19696) Microwave energy storage in resonant cavities.** Alvarez, R.A. (Lawrence Livermore National Lab., CA (USA)). Feb 1983. Contract W-7405-ENG-48. 62p. NTIS, PC A04/MF A01. Order Number DE83010818.

One method of generating short, high-power microwave pulses is to store rf energy in a resonant cavity over a relatively long fill time and extract is rapidly. A power gain roughly equal to the ratio of fill time to extraction time can be obtained. During the filling of a resonant cavity some of the energy is lost in heating the cavity walls, and some will generally be reflected at the input coupling of the cavity. In this paper we discuss the time dependence of the stored energy and related quantities and the way in which it depends on the coupling of the source to the cavity.

30107 **Pressure charged airlift pump.** Campbell, G.K. (to Dept. of Energy). US Patent 4,373,867. 15 Feb 1983. Filed date 15 Aug 1980. vp.

PAT-APPL-178653.

A pumping system is described for pumping fluids, such as water with entrained mud and small rocks, out of underground cavities such as drilled wells, which can effectively remove fluids down to a level very close to the bottom of the cavity and which can operate solely by compressed air pumped down through the cavity. The system utilizes a subassembly having a pair of parallel conduit sections adapted to be connected onto the bottom of a drill string utilized for drilling the cavity, the drill string also having a pair of coaxially extending conduits. The subassembly includes an upper portion which has means for connection onto the drill string and terminates the first conduit of the drill string in a plenum. A compressed air-driven pump is suspended from the upper portion. The pump sucks fluids from the bottom of the cavity and discharges them into the second conduit. Compressed air pumped down through the first conduit to the plenum powers the compressed air-driven pump and aerates the fluid in the second conduit to lift it to the earth's surface.

30108 **All-metal valve structure for gas systems.** Baker, R.W.; Pawlak, D.A.; Ramey, A.J. US Patent Application 6-387,114. 10 Jun 1982. 13p. Contract AC04-76DP00053.

A valve assembly with a resilient metal seat member is disclosed for providing a gas-tight seal in a gas handling system. The valve assembly also includes a valve element for sealing against the valve seat member; and an actuating means for operating the valve element. The valve seat member is a one-piece stainless steel ring having a central valve port and peripheral mounting flange, and an annular corrugation in between. A groove between the first and second ridges serves as a flexure zone during operation of the valve member and thus provides the seating pressure between the inner ridge or valve seat and the valve element. The outer annular ridge has a diameter less than said valve element to limit the seating motion of the valve element, preventing non-elastic deformation of the seat member.

30109 **Grapple assembly.** Schmid, F.L. US Patent Application 6-384,307. 2 Jun 1982. 11p. Contract AC05-78OR05869.

A grapple includes a pivotal L-shaped catch and a lever arranged to move the catch to an object-releasing position when the lever engages the object.

30110 **Active magnetic regenerator.** Barclay, J.A.; Steyert, W.A. (to Dept. of Energy). US Patent 4,332,135. 1 Jun 1982. Filed date 27 Jan 1981. vp.

PAT-APPL-228836.

The disclosure is directed to an active magnetic regenerator apparatus and method. Brayton, stirling, ericsson, and carnot cycles and the like may be utilized in an active magnetic regenerator to provide efficient refrigeration over relatively large temperature ranges.

30111 **Protective supplied-breathing-air garment.** Childers, E.L.; von Hortenau, E.F. US Patent Application 6-383,048. 28 May 1982. 24p. Contract AC04-76DP03533.

A breathing-air garment for isolating a wearer from hostile environments containing toxins or irritants is disclosed. The garment includes a suit and a separate head-protective enclosure or hood engaging a suit collar in sealing attachment. The hood and suit collar are cylindrically shaped and dimensioned to enable the wearer to withdraw his hands from the suit sleeves to perform manual tasks within the hood interior. Breathing air is supplied from an external air line with an air-delivery hose attached to the hood interior. The hose feeds air into an annular halo-like fiber-filled plenum having spaced discharge orifices attached to the hood top wall. A plurality of air exhaust/check valves located at the suit extremities cooperate with the hood air-delivery system to provide a cooling flow of circulating air from the hood throughout the suit interior. A suit entry seal provided on the suit sealed with an adhesive sealing flap.

30112 **Axial static mixer.** Sandrock, H.E. US Patent Application 6-375,523. 6 May 1982. 27p. Contract AC04-76DP00656.

Static axial mixing apparatus includes a plurality of channels, forming flow paths of different dimensions. The axial mixer includes a flow adjusting device for adjustable selective control of flow resistance of various flow paths in order to provide substantially identical flows through the various channels, thereby reducing nonuniform coating of interior surfaces of the channels. The flow adjusting device may include diaphragm valves, and may further include a pressure regulating system therefor.

30113 **Simulation of the energy saver refrigeration system.** Barton, H.R.; Mullholland, G.T.; Nicholls, J.E. (Fermi National Accelerator Lab., Batavia, IL). *Advances in Cryogenic Engineering;* **27**: 541-548(1982). (CONF-810835—).

From 1981 cryogenic engineering conference; San Diego, CA, USA (10 Aug 1981).

An interactive, software simulator is described as has been developed to calculate the refrigeration available from the energy saver refrigeration system, Fermilab Energy Saver. The refrigeration system simulator incorporates models of the components which have been developed to quantitaviley describe changes in system performance. The simulator output is presented in a real-time display which has been used to search for the optimal operating conditions of the Satellite-Central system, to examine the effect of an extended range of operating parameters and to identify equipment modifications which would improve the system performance. The method for simulation calculations is described. The computer simulation programs are given, with a sample display illustrated. The comparison with central liquefier data is presented. The results for the satellite refrigerator are shown with apposite charts. Some applications of simulation are outlined.

30114 **Static VAR compensator using a superconducting coil.** Boenig, H.; Cibulka, F. (Los Alamos Natl Lab, NM, USA). pp 8p, Paper 82WM 177-4 of IEEE Power Engineering Society winter meeting. New York, NY; IEEE (1982).

From IEEE Power Engineering Society winter meeting; New York, NY, USA (30 Jan 1982).

A superconducting coil has virtually no losses for a dc current. To utilize this feature in a static VAR compensator application the conventional conversion must be modified to obtain variable ac currents with a constant coil current. In the description of a recently introduced control scheme of a bridge converter it is shown that by the method of variable free-wheeling the line currents of a converter remains nearly constant. In this paper the novel static VAR circuit, called SAVAR (Superconducting Application for VAR control) is analyzed, and some derived voltage and current shapes are compared with experimental results. A 40 MVA

SAVAR system, including the appropriate harmonic filters, is designed and compared technically and economically with a conventional static VAR generator. It is concluded that the dynamic characteristics of the SAVAR support operation in electric utility systems. At this time the economic advantages of a SAVAR system are marginal. However, continuing increases in energy cost are factors which could give additional economic benefits to SAVAR in the future. 4 refs.

30115 **Ultraprecision machining of optics at Los Alamos.** Rhorer, R.L.; Gauler, A.L.; Colston, E.W.; Ruhe, J.R. (Los Alamos National Lab., NM). *Proceedings of the Society of Photo-Optical Instrumentation Engineers;* **306**: 122-129(1982).

From SPIE contemporary methods of opticál fabrication; San Diego, CA, USA (25 Aug 1981).

Ultraprecision machine tools are used at the Los Alamos National Laboratory for single-point diamond turning of optics and other precision parts. Measurements of a 50-mm-diam copper flat illustrate the quality of a part that can be machined on the Moore No. 3 lathe. Measurements of a 0.4-m-diam aluminum mirror with a 20-m radius of curvature are presented as an example of a part machined on the Moore No. 5 lathe. A varying frequency sine wave grating shows a type of special optical grating that can be produced using the Pneumo lathe.

30116 **Apparatus and method for detecting a magnetic anomaly contiguous to remote location by SQUID gradiometer and magnetometer systems.** Overton, W.C. Jr.; Steyert, W.A. Jr. US Patent Application 6-266,247. 22 May 1981. 17p. Contract W-7405-ENG-36.

A superconducting quantum interference device (SQUID) magnetic detection apparatus detects magnetic fields, signals, and anomalies at remote locations. Two remotely rotatable SQUID gradiometers may be housed in a cryogenic environment to search for and locate unambiguously magnetic anomalies. The SQUID magnetic detection apparatus can be used to determine the azimuth of a hydrofracture by first flooding the hydrofracture with a ferrofluid to create an artificial magnetic anomaly therein.

4203 Lasers

REFER ALSO TO CITATION(S) 29267, 30230, 30252, 30891

30117 **(LA-UR—83-706) Subharmonic triple buncher for a high-efficiency free-electron laser.** Fraser, J.S. (Los Alamos National Lab., NM (USA)). 1983. Contract W-7405-ENG-36. 4p. (CONF-830311—70). NTIS, PC A02/MF A01. Order Number DE83009957.

From Particle accelerator conference; Santa Fe, NM, USA (21 Mar 1983).

A high-efficiency free-electron laser oscillator experiment is being constructed at Los Alamos National Laboratory. A buncher system has been designed to deliver 30-ps, 5-nC electron bunches to a 20-MeV standing-wave linac at the 60th subharmonic of the 1300-MHz accelerator frequency. The first 108.3-MHz buncher cavity accepts a 5-ns, 5-A peak current pulse from a triode gun. Following a 120-cm drift space, a second 108.3-MHz cavity is used, primarily to enhance the bunching of the trailing half of the bunch. A 1300-MHz cavity with 20-cm drift spaces at each end completes the beamline components. The bunching process continues into the linac's first three accelerating cells. Two thin iron-shielded lenses and seven large-diameter solenoids provide axial magnetic fields for radial focusing.

30118 **(LA-UR—83-827) High-efficiency free-electron laser results.** Boyer, K.; Baru, C.A.; Newnam, B.E.; Stein, W.E.; Warren, R.W.; Winston, J.G.; Young, L.M. (Los Alamos National Lab., NM (USA)). 1983. Contract W-7405-ENG-36. 4p. (CONF-830311—48). NTIS, PC A02/MF A01. Order Number DE83010076.

From Particle accelerator conference; Santa Fe, NM, USA (21 Mar 1983).

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Results obtained with a tapered-wiggler free-electron laser demonstrate the concepts proposed by Morton for enhanced efficiency and show deceleration of electrons by as much as 7%, and extraction of more than 3% of the total electron-beam energy as laser energy when the laser is operated as an amplifier. The experiment is presently being reconfigured to examine its performance as a laser oscillator.

30119 **Resonantly enhanced method for generation of tunable, coherent vacuum-ultraviolet radiation.** Glownia, J.H.; Sander, R.K. US Patent Application 6-393,251. 29 Jun 1982. 22p. Contract W-7405-ENG-36.

Carbon Monoxide vapor is used to generate coherent, tunable vacuum ultraviolet radiation by third-harmonic generation using a single tunable dye laser. The presence of a nearby electronic level resonantly enhances the nonlinear susceptibility of this molecule allowing efficient generation of the vuv light at modest pump laser intensities, thereby reducing the importance of a six-photon multiple-photon ionization process which is also resonantly enhanced by the same electronic level but no higher order. By choosing the pump radiation wavelength to be of shorter wavelength than individual vibronic levels used to extend tunability stepwise from 154.4 to 124.6 nm, and the intensity to be low enough, multiple-photon ionization can be eliminated. Excitation spectra of the third-harmonic emission output exhibit shifts to shorter wavelength and broadening with increasing CO pressure due to phase matching effects. Increasing the carbon monoxide pressure, therefore, allows the substantial filling in of gaps arising from the stepwise tuning thereby providing almost continuous tunability over the quoted range of wavelength emitted.

30120 **Optical harmonic generator.** Summers, M.A.; Eimerl, D.; Boyd, R.D. US Patent Application 6-387,060. 10 Jun 1982. 27p. Contract W-7405-ENG-48.

A pair of uniaxial birefringent crystal elements are fixed together to form a serially arranged, integral assembly which, alternatively, provides either a linearly or elliptically polarized second-harmonic output wave or a linearly polarized third-harmonic output wave. The extraordinary or e directions of the crystal elements are oriented in the integral assembly to be in quadrature (90°). For a second-harmonic generation in the Type-II-Type-II angle tuned case, the input fundamental wave has equal amplitude o and e components. For a third-harmonic generation, the input fundamental wave has o and e components whose amplitudes are in a ratio of 2:1 (o:e reference first crystal). In the typical case of a linearly polarized input fundamental wave this can be accomplished by simply rotating the crystal assembly about the input beam direction by 10°. For both second and third harmonic generation input precise phase-matching is achieved by tilting the crystal assembly about its two sensitive axeses (o).

30121 **Microwave-triggered laser switch.** Piltch, M.S. US Patent Application 6-379,797. 19 May 1982. 13p. Contract W-7405-ENG-26.

A high-repetition rate switch is described for delivering short duration, high-powered electrical pulses from a pulsed-charged dc power supply. The present invention utilizes a microwave-generating device such as a magnetron that is capable of producing high-power pulses at high-pulse repetition rates and fast-pulse risetimes for long periods with high reliability. The rail-gap electrodes provide a large surface area that reduces induction effects and minimizes electrode erosion. Additionally, breakdown is initiated in a continuous geometric fashion that also increases operating lifetime of the device.

30122 **Two-dimensional optimization of free-electron-laser designs.** Prosnitz, D.; Haas, R.A. US Patent Application 6-374,655. 4 May 1982. 23p. Contract W-7405-ENG-48.

Off-axis, two-dimensional designs for free electron lasers are described that maintain correspondence of a light beam with a synchronous electron at an optimal transverse radius $r > 0$ to achieve increased beam trapping efficiency and enhanced laser beam wavefront control so as to decrease optical beam diffraction and other deleterious effects.

30123 Ultraviolet phase conjugation and its practical implications. Feldman, B.J.; Fisher, R.A.; Shapiro, S.L. (Los Alamos National Lab., NM). *Proceedings of the Society of Photo-Optical Instrumentation Engineers;* **288**: 253-257(1981).

From Los Alamos conference on optics; Los Alamos, NM (USA) (7-10 Apr 1981).

We report the first demonstration of uv phase conjugation. Using a 15 psec, 2660 A pulse, 0.1% conjugate reflectivities were obtained via degenerate four-wave mixing in 1-mm samples of CS_2 mixtures. While pure CS_2 did not exhibit the effect, dilution in several uv transmitting solvents opened up a concentration-tunable (2450 A to 2850 A) spectral window, allowing the optical Kerr effect to be utilized. Weaker phase conjugation at 2660 A was also observed in other Kerr media and in saturable absorber media.

4204 Heat Transfer And Fluid Flow

REFER ALSO TO CITATION(S) 29592, 29613, 29641, 29700, 29701, 30099, 30395

30124 (AAEC/E—528) Investigation of critical heat fluxes in vertical tubes internally cooled by Freon-12. Part II - The development of a critical heat flux correlation for uniformly heated tubes. Green, W.J. (Australian Atomic Energy Commission Research Establishment, Lucas Heights). Dec 1981. 49p. NTIS (US Sales Only), PC A03/MF A01. Order Number DE83700483.

Based on the parameter groups derived from a dimensional analysis, a correlation for predicting critical heat fluxes (CHF) in a uniformly heated tube, cooled internally by Freon-12, has been developed by systematically examining experimental data to establish the interrelationship of these dimensionless groups. Although the basic correlation agrees with much experimental data, it is inaccurate for short tubes or low mass fluxes. To compensate for these effects, corrective terms were introduced to provide a more generalised form. The correlation has been tested against approximately 2000 experimental data. It was found that, apart from data at low exit qualities (less than 0.1) or short boiling lengths less than approximately 50, the correlation agrees with the data to within +- 10 per cent for boiling length ratios less than approximately 150; for values greater than 150, more than 90 per cent of points agree with the correlation to within +- 5 per cent.

30125 (AAEC/E—532) Adaptation of a Freon-12 critical heat flux correlation to correlate water data from uniformly heated vertical tubes. Part I: Based on critical heat flux data for water at pressures of 3 to 14 MPa. Green, W.J. (Australian Atomic Energy Commission Research Establishment, Lucas Heights). Dec 1981. 34p. NTIS (US Sales Only), PC A03/MF A01. Order Number DE83700484.

Comparisons have been made between experimental critical heat flux (CHF) data for upflow of water in uniformly heated vertical tubes and values calculated from an empirical CHF correlation developed from Freon-12 data. When this correlation is re-evaluated to account for vapour Prandtl number effects, very good agreement is obtained between experimental data and calculated values over a wide range of coolant conditions. Comparison of values calculated from the revised correlation with 2063 sets of CHF data obtained from experiments with water in vertical, uniformly heated tubes shows a mean ratio of the calculated to experimental CHF of 0.82 and an r.m.s. error of 5.8 per cent for the following coolant conditions: (1) local pressure of 3.4 to 12 MPa; (2) mass flux greater than approx. 300 kg $s^{-1}m^{-2}$, and (3) thermal equilibrium value of exit quality greater than 0.1.

30126 (AAEC/E—536) Adaptation of a Freon-12 CHF correlation to apply for water in uniformly heated vertical tubes. Part 2: Based on CHF data for water at pressures in the range 6-20 MPa. Green, W.J. (Australian Atomic Energy Commission Research Establishment, Lucas Heights). Mar 1982. 28p. NTIS (US Sales Only), PC A03/MF A01. Order Number DE83700485.

An examination of more than 5000 sets of experimental data for critical heat flux (CHF) in uniformly heated vertical tubes internally cooled by high pressure water has shown that the CHF correlation proposed in Part 1 of this work is accurate for water at pressures up to approximately 17 MPa, provided that minor modifications are made to the Prandtl number index, and the saturation boiling length function. For pressures greater than 17 MPa, CHF values calculated from the correlation are increasingly lower than the experimental data, particularly at low saturation boiling length ratios (<100). This deficiency results from the significance of the surface tension number in the correlation and the accuracy to which the values of surface tension and latent heat are known as they approach zero at the critical pressure. As in the previous work, data have been excluded in which either the mass flux is less than 300 kg s^{-1} m^{-2} or thermal equilibrium exit qualities are less than 0.1.

30127 (ANL—83-18) Experiments on tubes conveying fluid. Jendrzejczyk, J.A.; Chen, S.S. (Argonne National Lab., IL (USA)). Feb 1983. Contract W-31-109-ENG-38. 55p. NTIS, PC A04/MF A01. Order Number DE83010692.

Tests are conducted for tubes conveying fluid for six types of support conditions. The objectives are to understand the dynamic characteristics of such systems for different support conditions and to explore the methods to control tube stability. Transition from one instability mechanism to another is examined, and the feasibility of using feedback control to increase the critical flow velocity is demonstrated.

30128 (ANL/FE—82-22) ANL Solids/Gas Flow Test Facility. Dates, L.R.; Bobis, J.P. (Argonne National Lab., IL (USA)). Sep 1982. Contract W-31-109-ENG-38. 61p. NTIS, PC A04/MF A01. Order Number DE83011026.

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The Solids/Gas Flow Test Facility (S/GFTF) has been designed and constructed at Argonne National Laboratory (ANL) to promote development, testing, evaluation, and calibration of instruments, not currently available but ultimately needed, for advanced large-scale coal-conversion and combustion plants. This instrument effort is part of a program in instrumentation and process control for coal conversion at ANL funded by the United States Department of Energy (DOE). The development program will not only be devoted to the evolvement of new instruments but will also include the exchange of information and cooperation with commercial-instrument suppliers and final plan users. The development data will ultimately be transferred to instrument suppliers for production. The instrument systems to be studied at the S/GFTF will include, but are certaintly not limited to: acoustic, capacitive, optical, and ultra-sonic flowmeters and coal-composition-analysis systems. The integrated facility with its data-acquisition system is capable of providing measured and controllable flow conditions in several vertical and horizontal test regions with various solid/gas concentrations that simulate flow conditions in coal-conversion plants.

30129 (CONF-8108157—1) Fluid-inertia effects in radial flow between oscillating, rotating parallel disks. Warinner, D.K.; Pearson, J.T. (Argonne National Lab., IL (USA); Purdue Univ., Lafayette, IN (USA). School of Mechanical Engineering). 1981. Contract W-31-109-ENG-38. 24p. NTIS, PC A02/MF A01. Order Number DE83009020.

From ASME/ASLE conference on lubrication; San Francisco, CA, USA (18 Aug 1981).

An order-of-magnitude analysis is applied to the Navier-Stokes equations and the continuity equation for isothermal, radial fluid flow between oscillating and rotating disks. This analysis investigates the four basic cases of (1) steady, radial flow, (2) unsteady, radial flow, (3) steady, spiral flow, and (4) unsteady, spiral flow. It is shown that dimensionless parameters of certain values for general cases will reduce the Navier-Stokes equations to simplified forms and thus render them amenable to closed form solutions for, say, the pressure distribution between oscillating, rotating disks. The analysis holds for laminar and turbulent flows and compressible and incompressible flows. The conditions that must be satisfied for one to reasonably neglect (1) rotation, (2) unsteady terms, and (3) convective terms are set forth. One result shown is that only rarely could one reasonably neglect the radial convective acceleration while retaining the radial local acceleration.

30130 (INIS-mf—7227) Numerical methods to solve the two-dimensional heat conduction equation. dos Santos, R.S. (Instituto Militar de Engenharia, Rio de Janeiro (Brazil)). Sep 1981. 127p. (In Portuguese). NTIS (US Sales Only), PC A07/MF A01. Order Number DE83701529.

A class of numerical methods, called 'Hopscotch Algorithms', was used to solve the heat conduction equation in cylindrical geometry. Using a time dependent heat source, the temperature versus time behaviour of cylindric rod was analysed. Numerical simulation was used to study the stability and the convergence of each different method. Another test had the temperature specified on the outer surface as boundary condition. The various Hopscotch methods analysed exhibit differing degrees of accuracy, few of them being so accurate as the ADE method, but requiring more computational operations than the later, were observed. Finally, compared with the so called ODD-EVEN method, two other Hopscotch methods, are more time consuming.

30131 Hydrodynamics of annular-dispersed flow. Ishii, M.; Kataoka, I. (Argonne Natl Lab, IL, USA). *American Society of Mechanical Engineers, Pressure Vessels and Piping Division,* [*Technical Report*] *PVP;* **64**: 1-18(1982). (CONF-820601—).

The interfacial drag, droplet entrainment, and droplet size distributions are important for detailed mechanistic modeling of annular dispersed two-phase flow. In view of this, recently developed correlations for these parameters are presented and discussed. The drag correlations for multiple fluid particle systems have been developed from a similarity hypothesis based on the mixture viscosity model. The results show that the drag coefficient depends on the particle Reynolds number and droplet concentration. The onset of droplet entrainment significantly alters the mechanisms of mass, momentum, and energy transfer between the film and gas core flow as well as the transfer between the two-phase mixture and the wall. By assuming the roll wave entrainment mechanism, the correlations for the amount of entrained droplet as well as for the droplet size distribution have been obtained from a simple model in collaboration with a large number of data. The comparison of the correlations with various data show satisfactory agreement. 31 refs.

30132 Equation for the latent heat of vaporization. Torquato, S. (General Motors Inst., Flint, MI); Stell, G.R. *Industrial and Engineering Chemistry Fundamentals;* **21**: No. 3, 202-205(1982).

An expression for the latent heat of vaporization of a fluid is formulated employing renormalization-group theory predictions for the thermodynamics of fluids in the vicinity of the critical point. A least-squares fit of the latent heat data of water is made using the general and relatively simple equation: $L = a_1 t/\sup\ \beta/ + a_2 t/\sup\ \beta^+ \Delta/ + a_4 t/\sup\ 1-\alpha+\beta/ + \Sigma M/\sub\ n=1/b/\sub\ n/t/\sup\ n/$, $3 \leq M \leq 5$, yielding predicted values that are in excellent agreement with the data throughout a wide range of temperature. The optimum value of the critical temperature, 373.92°C, is found to be somewhat lower than the tabulated value.

30133 Proceedings of condensed papers: sixteenth southeastern seminar on thermal sciences. Veziroglu, T.N. (ed.). Coral Gables, FL; University of Miami (1982). 191p. (CONF-8204120—). Univ. of Miami, P.O. Box 248294, Coral Gables, FL 33124 $40.00.

From 16. Southeastern seminar on thermal sciences; Miami, FL, USA (19 Apr 1982).

This volume includes extended abstracts of papers presented at the 16th Annual Southeastern Seminar on Thermal Sciences. The various sessions of the seminar dealt with: thermophysical properties of materials; combustion heat transfer; two-phase flow and heat transfer; basic heat transfer, and measurement techniques. (LCL)

30134 Dusty gas influences on transport in turbulent erosive propellant flow. Buckingham, A.C. (Lawrence Livermore National Lab., CA). *AIAA (American Institute of Aeronautics and Astronautics) Journal;* **19**: No. 4, 501-508(Apr 1981). Contract W-7405-ENG-48.

From AIAA aerospace sciences meeting; Pasadena, CA, USA (14 Jan 1980).

A theoretical-numerical model is introduced that relates the influences of particles on erosive transport in a turbulent reactive boundary layer. Specifically, this discussion concerns additive particles used to suppress wall erosion in gun propellant turbulent combustion. The turbulent-particle interactions are modeled with random particulate motion computations. These produce particulate trajectories, distributions, and momenta. The interaction model includes effects of particle size, mass, and rotation as well as two-particle hard sphere collisions. The main purpose of this work is to evaluate the effects of the particles on the energy, mass, and momentum transport in the erosive wall boundary-layer region. Neglecting thermal relaxation, the heat transfer rates are found to be substantially reduced when particles are added. The most significant reduction occurs when smaller diameter (0.2 μm) particles are introduced rather than larger diameter particles (5 μm).

4205 Materials Testing

REFER ALSO TO CITATION(S) 29549, 29897, 29924

30135 (UCRL—88942) Digital signal-processing techniques used for improving the resolution of B-scans in 1 second or less per waveform. McKinney, R.L.; Boyd, D.; Kuramoto, A.; McDonald, W. (Lawrence Livermore National Lab., CA (USA)). 1983. Contract W-7405-ENG-48. 18p. (CONF-830430—1). NTIS, PC A02/MF A01. Order Number DE83009810.

From 14. symposiumm on nondestructive evaluation; San Antonio, TX, USA (19 Apr 1983).

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The application of several signal-processing techniques for improved resolution of ultrasonic B-scans is complete. Techniques such as split-spectrum processing, analytic-signal magnitude, and various windowing procedures have been implemented. A transducer pulser and receiver are used in conjunction with a data acquisition system to send, receive, digitize, and store ultrasonic waveforms. The digitized waveforms are processed using an array processor. The results have proved favorable both in processing time and in additional information provided by the techniques. The array processor is installed in a DEC 11/23 computer and is accessed using simple Fortran calls. All of the processing techniques require at least 2 FFTs and one of them, split-spectrum processing, requires as many as 20 FFTs per waveforms. Even with this extensive computation each technique is implemented in 1 second or less.

30136 Method and apparatus for generating a natural crack. Fulton, F.J.; Honodel, C.A.; Holman, W.R.; Weingart, R.C. US Patent Application 6-375,645. 6 May 1982. 21p. Contract W-7405-ENG-48.

A method and apparatus for generating a measurable natural crack includes forming a primary notch in the surface of a solid material. A nonsustained single pressure pulse is then generated in the vicinity of the primary notch, reuslting in the formation of a shock wave which travels through the material. The shock wave creates a measurable natural crack within the material which extends from the primary notch. The natural crack formed possesses predictable geometry, location and orientation.

30137 Collapse of thick-walled cylinders under external pressure. Simonen, F.A.; Shippel, R.J. Jr. (Battelle Pacific Northwest Lab., Richland, WA). *Experimental Mechanics;* **22**: No. 2, 41-48(Feb 1982). Contract AC06-76RL01830.

From 4. SESA International Congress on Experimental Mechanics; Boston, MA (USA) (25-30 May 1980).

Hydrostatic collapse tests performed on thick-walled capped cylinders are described. Finite-element predictions which include the effects of end-cap stiffening, cross-section ovalities and material strain hardening are compared to experimental results. The analyses correctly predict the sequence of events leading to collapse, but experimental failure pressures are significantly below predictions. It is concluded that the von Mises yield criterion used in the analysis did not accurately represent the yield behavior of the 1018 steel tubing material of the test cylinders for the triaxial-stress conditions of interest.

30138 **Application of metal single crystal wedges to high frequency Rayleigh wave propagation.** Fisher, E.S.; Zwick, D.; VanHook, D.; Henkleman, G.; Smith, B. (Argonne National Lab., IL). *Journal of Nondestructive Evaluation;* 2: No. 3/4, 231-239(1981).

Techniques for propagating Rayleigh waves with frequencies varying from < 1 to 270 MHz were developed for the purpose of nondestructive evaluation of composition or defect gradients near the surface of nonpiezoelectric solids. The surface waves with frequencies greater than 15 MHz were obtained from a novel technique using single crystal wedges, whereas the low frequency waves were produced by a previously used high voltage impulse. Measurements of Rayleigh wave velocities on single crystals of Ge and Al were performed as a test of accuracy and precision and are compared with calculated values.

4207 Vacuum Engineering

30139 **(GEPP-TIS—681a) Thermal cycling and torque analysis of an ultrahigh-vacuum flange.** Fuente, A.O. (General Electric Co., St. Petersburg, FL (USA). Neutron Devices Dept.). 15 Apr 1983. Contract AC04-76DP00656. 18p. NTIS, PC A02/MF A01. Order Number DE83009708.

A vacuum assembly in a specialized ultrahigh-vacuum exhaust/leak detection processing system was designed to incorporate replaceable vacuum sealing-flange ports. The vacuum-processing operation required that these ports be capable of repeatable thermal cycling, from ambient to 525 +- 25°C, and be torqued between the range of 17 to 50 foot-pounds prior to each thermal cycle while guaranteeing a leak-free seal to less than 1 x 10^{-12} std cm^3/s. Through computer analysis and documented experiments, this design concept was proven to be feasible. One of the major breakthroughs was the employment of nickel gaskets for sealing as opposed to OFHC copper (standard high vacuum gasket material). This nickel gasket proved to be vastly superior to copper in its sealing reliability with respect to thermal cycling at elevated temperatures. Torque analysis results have shown that these ports could be torqued to as high as 50 ft-lbs, both at ambient and elevated temperatures, and still be leak-free.

30140 **(GEPP-TIS—682a) Computer uses in vacuum equipment and processes.** Kline, F.M. (General Electric Co., St. Petersburg, FL (USA). Neutron Devices Dept.). 15 Apr 1983. Contract AC04-76DP00656. 18p. NTIS, PC A02/MF A01. Order Number DE83009711.

The General Electric Company Neutron Devices Department (GEND) designs and builds varied ultrahigh vacuum processing systems for in-house manufacturing. This paper describes a particularly complex vacuum system in terms of its computer interface design and gives and overview of the vacuum process station hardware utilized, followed by a component description of the electronics control console. The emphasis of this paper is on justification of a computer-based design, computer interface hardware, software considerations, and human engineering. Future trends, general system design philosophies and conclusions are presented based on the experience gained from the example system which has been successfully implemented in manufacturing at GEND.

30141 **Test of a cryogenic helium pump.** Lue, J.W.; Herz, W.; Miller, J.R.; Walstrom, P.L. (Oak Ridge National Lab., Oak Ridge, TN). *Advances in Cryogenic Engineering;* 27: 785-790(1982). (CONF-810835—).

From 1981 cryogenic engineering conference; San Diego, CA, USA (10 Aug 1981).

A cryogenic helium pump is described with detailed schematic drawings. The test setup and results are given and the pump characteristics charted. The calculations for the thermal efficiency are presented with mass flow rate as a function of pump speed shown on a chart. Conclusions include the fact that a helium pump of this type would be suitable for the use of flowing supercritical helium through ICS magnets. It has pumped supercritical helium up to 7.5 atm with a pump head up to 2.8 atm.

4208 Electronic Circuits And Devices

REFER ALSO TO CITATION(S) 30235, 30301

30142 **(GEPP-OP—659) Discharge modes at the anode of a vacuum arc.** Miller, H.C. (General Electric Co., St. Petersburg, FL (USA)). 1982. Contract AC04-76DP00656. 5p. (CONF-821024—8). NTIS, PC A02/MF A01. Order Number DE83010323.

From 10. international symposium on discharges and electrical insulation in vacuum; Columbia, SC, USA (25 Oct 1982).

The two most common anode modes in a vacuum arc are the low-current mode, where the anode is basically inert; and the high-current mode with a fully developed anode spot. This anode spot is very bright, has a temperature near the boiling point of the anode material, and is a copious source of vapor and energetic ions. However, other anode modes can exist. A low-current vacuum arc with electrodes of readily sputterable material will emit a flux of sputtered atoms from the anode. At intermediate currents an anode footpoint can form. This footpoint is luminous, but much cooler than a true anode spot. Finally, a high current mode can exist where several small anode spots are present instead of a single large anode spot.

30143 **(LA-UR—83-608) Regulator to control current sharing among parallel-connected power transistors.** Wells, F.D.; Higgins, E.F.; Mauro, M.E. (Los Alamos National Lab., NM (USA)). 1983. Contract W-7405-ENG-36. 4p. (CONF-830311—76). NTIS, PC A02/MF A01. Order Number DE83009941.

From Particle accelerator conference; Santa Fe, NM, USA (21 Mar 1983).

A current regulator is described that controls the peak current of a power transistor driving the inductive load, such as magnet coils. Presently, the current pulse has a 0.1 to 1-ms adjustable duration with duty cycle to 5%. Ultimately, the pulse length must be ~ 7 ms with 50% duty cycle. The peak current nominally is 200 A, as set by a reference pulse. Several transistors, each controlled by an individual regulator, are connected in parallel to provide the total peak load current. The regulators compensate for differences between the power transistors and assure equal current sharing among the collectors. The regulator comprises an 8-bit multiplying digital-to-analog (D/A) converter that drives the base of the power transistor, an 8-bit up-down counter, an analog differencing circuit, and a comparator. For control purposes, a current-sensing resistor in the transistor's collector produces the second input to the differencing circuit. Regulation is accomplished over a collector current range of 200 +- 50 A per stage.

30144 **(LA-UR—83-756) 150-kW, 450-MHz gyrocon rf generator.** Tallerico, P.J. (Los Alamos National Lab., NM (USA)). 1983. Contract W-7405-ENG-36. 4p. (CONF-830311—51). NTIS, PC A02/MF A01. Order Number DE83009974.

From Particle accelerator conference; Santa Fe, NM, USA (21 Mar 1983).

The output-power and conversion efficiency of the Los Alamos gyrocon were increased by a factor of 150 in the past year. Major improvements in the phase- and amplitude-control system and in understanding the electron multipactor and surface-conditioning processes increased the output power. The highest measured efficiency on this gyrocon is 23%, which was obtained with several combinations of parameters. Both the output power and the efficiency are a factor of 3 below the design values, and several possibilities are being examined to remove the discrepancy between theory and experiment.

30145 **(LA-UR—83-851) Criteria for vacuum breakdown in rf cavities.** Peter, W.; Faehl, R.J.; Kadish, A.; Thode, L.E. (Los Alamos National Lab., NM (USA)). 1983. Contract W-7405-ENG-36. 4p. (CONF-830311—44). NTIS, PC A02/MF A01. Order Number DE83010098.

From Particle accelerator conference; Santa Fe, NM, USA (21 Mar 1983).

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A new high-voltage scaling based on Kilpatrick's criterion is presented that suggests that voltages more than twice the Kilpatrick limit can be obtained with identical initial conditions of vacuum and surface cleanliness. The calculations are based on the experimentally observed decrease in secondary electron emission with increasing ion-impact energy above 100 keV. A generalized secondary-emission package has been developed to simulate actual cavity dynamics in conjunction with our 2 1/2-dimensional fully electromagnetic particle-in-cell code CEMIT. The results are discussed with application to the suppression of vacuum breakdown in rf accelerator devices.

30146 **(MLR—1465) Rep-rated long-life capacitor development. Phase I technical report, 1 April 1981-30 September 1982.** Galperin, I. (Maxwell Labs., Inc., San Diego, CA (USA)). 31 Mar 1983. Contract AC04-81AL16320. 124p. NTIS, PC A06/MF A01. Order Number DE83009315.

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Extensive studies were made characterizing polypropylene and polyolefin resins for capacitor film usage. One polypropylene resin was selected for capacitor POP film fabrication. A polyolefin resin was upgraded for POP film fabrication. Two new capacitor films were developed - a post orientation processed, two layer, polypropylene film and a polyolefin resin film. New criteria for judging film quality have been developed and instituted. A capacitor film test plan has been formulated. Test capacitor designs and a capacitor test plan have been devised. A new Maxwell Laboratories Rep Rate Capacitor Test Facility is under construction to be operational in Phase II.

30147 **(SAND—82-2362) Simulation of a binary phase-locked loop.** Goggans, P.M. (Sandia National Labs., Albuquerque, NM (USA)). Jan 1983. Contract AC04-76DP00789. 28p. NTIS, PC A03/MF A01. Order Number DE83010974.

This report describes simulation of a binary phase-locked loop (BPLL), the synthronizing circuit in the Aircraft Security Radar System. I explain the BPLL's operation, describe the simulating algorithm, and exemplify simulations of the BPLL to illustrate how performance is optimized by adjustment of loop filter parameters.

30148 **Low-voltage gas-discharge device.** Kovarik, V.J.; Hershcovitch, A.; Prelec, K. US Patent Application 6-386,370. 8 Jun 1982. 13p. Contract AC02-76CH00016.

An electronic device of the type wherein current flow is conducted by an ionized gas comprising a cathode of the type heated by ionic bombardment, an anode, means for maintaining a predetermined pressure in the region between the anode and the cathode and means for maintaining a field in the region is described. The field, which is preferably a combined magnetic and electric field, is oriented so that the mean distance traveled by electrons before reaching the anode is increased. Because of this increased distance traveled electrons moving to the anode will ionize a large number of gas atoms, thus reducing the voltage necessary to initiate gas breakdown. In a preferred embodiment the anode is a main hollow cathode and the cathode is a smaller igniter hollow cathode located within and coaxial with the main hollow cathode. An axial magnetic field is provided in the region between the hollow cathodes in order to facilitate gas breakdown in that region and initiate plasma discharge from the main hollow cathode.

30149 **Infrared photoemitting diode having reduced work function.** Hirschfeld, T.B. US Patent Application 6-375,518. 6 May 1982. 20p. Contract W-7405-ENG-48.

In electro-optical detectors which include as elements a photoemitting photocathode and anode, a photoemitting diode is fabricated which lowers the diode's work function, thus reducing the cooling requirement typically needed for this type of device. The work function is reduced by sandwiching between the photocathode and anode a liquid meidum of the formula NR_3 and having an electron affinity for the electrons of the photocathode, which liquid medium permits free electrons leaving the photocathode to remain as stable solvated species in the liquid medium. Thus, highly light-absorbent, and therefore thin, metallic layers can be used for detection, thereby reducing dark current at a given temperature, with a consequent reduction in cooling requirements at constant detector performance.

30150 **Emitron: microwave diode.** Craig, G.D.; Pettibone, J.S.; Drobot, A.T. US Patent Application 6-375,529. 6 May 1982. 22p. Contract W-7405-ENG-48.

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The invention comprises a new class of device, driven by electron or other charged particle flow, for producing coherent microwaves by utilizing the interaction of electromagnetic waves with electron flow in diodes not requiring an external magnetic field. Anode and cathode surfaces are electrically charged with respect to one another by electron flow, for example caused by a Marx bank voltage source or by other charged particle flow, for example by a high energy charged particle beam. This produces an electric field which stimulates an emitted electron beam to flow in the anode-cathode region. The emitted electrons are accelerated by the electric field and coherent microwaves are produced by the three dimensional spatial and temporal interaction of the accelerated electrons with geometrically allowed microwave modes which results in the bunching of the electrons and the pumping of at least one dominant microwave mode.

30151 **Low-noise pulse conditioner.** Bird, D.A. US Patent Application 6-274,120. 16 Jun 1981. 18p. Contract W-7405-ENG-26.

A low-noise pulse conditioner is provided for driving electronic digital processing circuitry directly from differentially induced input pulses. The circuit uses a unique differential-to-peak detector circuit to generate a dynamic reference signal proportional to the input peak voltage. The input pulses are compared with the reference signal in an input network which operates in full differential mode with only a passive input filter. This reduces the introduction of circuit-induced noise, or jitter, generated in ground referenced input elements normally used in pulse conditioning circuits, especially speed transducer processing circuits. This circuit may be used for conditioning the sensor signal from the Fidler coil in a gas centrifuge for separation of isotopic gaseous mixtures.

4210 Combustion Systems

REFER ALSO TO CITATION(S) 28967, 28977, 29293, 29814

30152 **(ANL/EES-TM—214) Experimental gas-fired pulse-combustion studies.** Blomquist, C.A. (Argonne National Lab., IL (USA)). Sep 1982. Contract W-31-109-ENG-38. 313p. NTIS, PC A14/MF A01. Order Number DE83009753.

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Experimental studies conducted at Argonne National Laboratory on a gas-fired, water-cooled, Helmholtz-type pulse combustion burner are discussed. In addition to the experimental work, information is presented on the evolution of pulse combustion, he types of pulse combustion burners and their applications, and the types of fuels used. Also included is a survey of other pertinent sutdies of gas-fired pulse combustion. The burner used in he Argonne research effort was equipped with adjustable air and gas flapper valves and was operated stably over a heat-input range of 30,000 to 200,000 Btu/h. The burner's overall heat transfer in the pulsating mode was 22 to 31% higher than when the unit was operated in the steady mode. Important phenomena discussed include (1) effects on performance produced by inserting a corebustor to change tailpipe diameter, (2) effects observed following addition of an air-inlet decoupling chamber to the unit, and (3) occurrence of carbon monoxide in the exhaust gas.

30153 **(DOE/ET/13146—T1) Turbulent combustion experiments and modeling. Technical progress report, September 29, 1980-December 31, 1980.** (General Electric Co., Schenectady, NY (USA). Corporate Research and Development Dept.). 1980. Contract AC04-78ET13146. 6p. NTIS, PC A02/MF A01. Order Number DE83007529.

The goal of this research effort is to contribute to the advancement of combustion design capabilities through development

and validation of modeling techniques, based upon new experimental data obtained from non-intrusive optical probes. During this reporting period, the following major activities have been carried out: (a) work directed toward coupling the Raman scattering and laser velocimetry scattering probes; and (b) efforts related to the effects in mixing in flames applied to the coalescence/dispersion model. Loss of an experimentalist staff member has occurred, who has specialized in laser velocimetry and associated signal processing electronics. Work will be delayed while undergoing the process required for replacing this person.

30154 **(DOE/ET/13146—T2) Turbulent combustion experiments and modeling. Technical progress report, April 2, 1981-July 1, 1981.** (General Electric Co., Schenectady, NY (USA). Corporate Research and Development Dept.). 1981. Contract AC04-78ET13146. 5p. NTIS, PC A02/MF A01. Order Number DE83007528.

The goal of this research effort is to contribute to the advancement of combustion design capabilities through development and validation of modeling techniques, based upon new experimental data obtained from non-intrusive optical probes. During this reporting period, the following major activities have been carried out: (a) work resulting in acquisition of considerable amounts of Raman data for H_2/air turbulent diffusion flames, leading to achievement of the limited set milestone for this effort; and (b) alterations to the Raman probe measurement system following this data set that result in improvements in accuracy of the flame thermodynamic data obtained. Loss of an experimentalist staff member has occurred, who has specialized in laser velocimetry and associated signal processing electronics. Work will be delayed while undergoing the process required for replacing this person.

30155 **(DOE/ET/13146—T3) Turbulent combustion experiments and modeling. Technical progress report, July 2, 1981-September 30, 1981.** (General Electric Co., Schenectady, NY (USA). Corporate Research and Development Dept.). 1981. Contract AC04-78ET13146. 6p. NTIS, PC A02/MF A01. Order Number DE83007527.

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The goal of this research effort is to contribute to the advancement of combustion design capabilities through development and validation of modeling techniques, based upon new experimental data obtained from non-intrusive optical probes. During this reporting period, the following major activities have been carried out: (a) acquisition of the final data sets for the Raman and laser velocimetry probes necessary to characterize the H_2/air flames, (b) exploration of problems associated with using low Btu gas flames, and (c) examination of the coalescence/dispersion model for ultimate use in predicting the desired results for this program.

30156 **(DOE/ET/13146—T4) Turbulent combustion experiments and modeling. Technical progress report, October 1, 1981-December 31, 1981.** (General Electric Co., Schenectady, NY (USA). Corporate Research and Development Dept.). 1981. Contract AC04-78ET13146. 4p. NTIS, PC A02/MF A01. Order Number DE83007526.

The goal of this research effort is to contribute to the advancement of combustion design capabilities through development and validation of modeling techniques, based upon new experimental data obtained from non-intrusive optical probes. During this reporting period, the following major activities have been carried out: (a) apparatus modifications and tests related to burning medium Btu (synthesis) gas fuel in the turbulent diffusion flame combustor; (b) improvements made to the initial flow field properties by better supports for the fuel tube; (c) beginning design of the final Raman detection system for synthesis gas fuel; and (d) change of direction in analytical modeling program.

30157 **(DOE/ET/13146—T5) Turbulent combustion experiments and modeling. Technical progress report, January 1, 1982-March 28, 1982.** (General Electric Co., Schenectady, NY (USA). Corporate Research and Development Dept.). 1982. Contract AC04-78ET13146. 7p. NTIS, PC A02/MF A01. Order Number DE83007525.

The goal of this research effort is to contribute to the advancement of combustion design capabilities through development and validation of modeling techniques, based upon new experimental data obtained from non-intrusive optical probes. During this reporting period, the following major activities have been carried out: (a) efforts related to equipment redesign (fuel tube supports and polychromator); (b) experimental studies of LV seeder design and performance; and (c) development of a no-fluctuation model approach.

30158 **(DOE/ET/13146—T6) Turbulent combustion experiments and modeling. Technical progress report, March 29, 1982-June 27, 1982.** (General Electric Co., Schenectady, NY (USA). Corporate Research and Development Dept.). 1982. Contract AC04-78ET13146. 7p. NTIS, PC A02/MF A01. Order Number DE83007524.

The goal of this research effort is to contribute to the advancement of combustion design capabilities through development and validation of modeling techniques, based upon new experimental data obtained from non-intrusive optical probes. During this reporting period, the following major activities have been carried out: (a) combustor tests for the syngas/air flames to be used in the remainder of this program; (b) work on background signal problems for Raman data acquisition with syngas/air flames; (c) design and fabrication of the polychromator system and the final configuration of the gas delivery system; (d) development of new computer programs; (e) refinement of NO detection procedures; and (f) development of model calculation methods based on use of pdfs.

30159 **(DOE/ET/13146—T7) Turbulent combustion experiments and modeling. Technical progress report, January 1, 1979-April 1, 1979.** (General Electric Co., Schenectady, NY (USA). Corporate Research and Development Dept.). 1979. Contract AC04-78ET13146. 8p. NTIS, PC A02/MF A01. Order Number DE83007333.

The goal of this research effort is to contribute to the advancement of combustion design capabilities through development and validation of modeling techniques, based upon new experimental data obtained from non-intrusive optical probes. During this reporting period, the following major activities have been carried out: (a) final design and construction of the turbulent jet diffusion flame tunnel; (b) analysis of spatial and temporal characteristics for simultaneous Raman scattering and laser velocimetry data acquisition; (c) development of signal processing concepts and simulated test of signal processing characteristics; (d) refurbishment of Raman spectrometer; and (e) tests of Reichardt model for flame analysis.

30160 **(DOE/ET/13146—T8) Turbulent combustion experiments and modeling. Technical progress report, July, 2 1979-September 30, 1979.** (General Electric Co., Schenectady, NY (USA). Corporate Research and Development Dept.). 1979. Contract AC04-78ET13146. 7p. NTIS, PC A02/MF A01. Order Number DE83007466.

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The goal of this research effort is to contribute to the advancement of combustion design capabilities through development and validation of modeling techniques, based upon new experimental data obtained from non-intrusive optical probes. During this reporting period, the following major activities have been carried out: (a) major tests of combustion tunnel flow characteristics; (b) tests of electronic circuitry, including the sample-and-holds; and (c) use of the GENMIX code for flow calculations.

30161 **(DOE/ET/13146—T9) Turbulent combustion experiments and modeling. Technical progress report, October 1, 1979-December 31, 1979.** (General Electric Co., Schenectady, NY (USA). Corporate Research and Development Dept.). 1979. Contract AC04-78ET13146. 6p. NTIS, PC A02/MF A01. Order Number DE83007467.

The goal of this research effort is to contribute to the advancement of combustion design capabilities through development and validation of modeling techniques, based upon new experimental data obtained from non-intrusive optical probes. During this reporting period, the following major activities have been carried out: (a) alignment of slits in the Raman scattering polychromator for detection of N_2, H_2O and H_2 concentrations, and for temperature; (b) tests of the sample-and-hold circuitry using actual Raman

signals, following the slit alignment procedures; (c) acquisition of a limited set of Raman scattering data, which was compared with theoretical values corresponding to an adiabatic flame; (d) consideration of departures of the Raman data from the simple theory; and (e) evaluation of fast vs. finite rate chemistry assumptions and the formulation of pdf calculations.

30162 **(DOE/ET/13146—T10) Turbulent combustion experiments and modeling. Technical progress report, January 1, 1980-March 30, 1980.** (General Electric Co., Schenectady, NY (USA). Corporate Research and Development Dept.). 1980. Contract AC04-78ET13146. 8p. NTIS, PC A02/MF A01. Order Number DE83007468.

The goal of this research effort is to contribute to the advancement of combustion design capabilities through development and validation of modeling techniques, based upon new experimental data obtained from non-intrusive optical probes. During this reporting period, the following major activities have been carried out: (a) accumulation of substantially increased amounts of Raman data for characterization of the H_2/air flames studied; (b) preliminary analysis of the departures of the data from simple theoretical predictions; (c) identification of experimental limitations caused by spectroscopic uncertainties; (d) new laser velocimetry data for initial conditions and bench tests for 2-color (i.e., 2-velocity-component) data acquisition; and (e) modeling analyses of pdf numerical calculation problems and of using Pratt's coalescence/dispersion model.

30163 **(DOE/ET/13146—T11) Turbulent combustion experiments and modeling. Technical progress report, March 31, 1980-June 29, 1980.** (General Electric Co., Schenectady, NY (USA). Corporate Research and Development Dept.). 1980. Contract AC04-78ET13146. 9p. NTIS, PC A02/MF A01. Order Number DE83007531.

The goal of this research effort is to contribute to the advancement of combustion design capabilities through development and validation of modeling techniques, based upon new experimental data obtained from non-intrusive optical probes. During this reporting period, the following major activities have been carried out: (a) experimental and analytical work aimed at understanding fundamental error sources in the laser velocimetry data, especially related to bias problems; (b) continued acquisition and analysis of Raman data, particularly related to departures from the adiabatic equilibrium (AE) model; (c) initial burning tests of flames containing hydrocarbon species; (d) improvements made in simulation and analysis of the H_2O vapor Raman signature, leading to improvement in the accuracy of H_2O vapor concentration determination; and (e) tests of the coalescence/dispersion model with experimental data provided by Birch et al (1978) and Kent (1972).

30164 **(DOE/ET/13146—T12) Turbulent combustion experiments and modeling. Technical progress report, June 30, 1980-September 28, 1980.** (General Electric Co., Schenectady, NY (USA). Corporate Research and Development Dept.). 1980. Contract AC04-78ET13146. 6p. NTIS, PC A02/MF A01. Order Number DE83007530.

The goal of this research effort is to contribute to the advancement of combustion design capabilities through development and validation of modeling techniques, based upon new experimental data obtained from non-intrusive optical probes. During this reporting period, the following major activities have been carried out: (a) comparison of the Raman data with new theoretical predictions made by Prof. R. Bilger (Univ. of Sydney, Australia), which confirm substantially our measurements; and (b) improvements in the comparison of the coalescence/dispersion modeling results with Kent's data (1972), and introduction of finite rate chemistry effects.

30165 **Combustion pinhole-camera system.** Witte, A.B. US Patent Application 6-379,798. 19 May 1982. 12p. Contract AC01-79ER10029.

A pinhole camera system is described utilizing a sealed optical-purge assembly which provides optical access into a coal combustor or other energy conversion reactors. The camera system basically consists of a focused-purge pinhole optical port assembly, a conventional TV vidicon receiver, an external, variable density light filter which is coupled electronically to the vidicon automatic gain control (agc). The key component of this system is the focused-purge pinhole optical port assembly which utilizes a purging inert gas to keep debris from entering the port and a lens arrangement which transfers the pinhole to the outside of the port assembly. One additional feature of the port assembly is that it is not flush with the interior of the combustor.

30166 **(NP-tr—3901609) Burner for gaseous fuel.** Coanda, H.; Muresan, G. (British Gas Corp., London). 1982. Translation of Romanian Patent 59066, 30 Sep 1975. 12p. NTIS (US Sales Only), PC A02/MF A01. Order Number DE83901609.

Portions are illegible in microfiche products.

A burner for gaseous fuel, which claims to obtain a stoichiometric and stable combustion is disclosed. It consists of an admission chamber provided with a perforated cover treaded into a body. Terminal part of the cover and the curvilinear extremity of the admission chamber, the circular nozzle forming at its extremity an adjustable slit through which the combustible gas, introducted by a pipe, passes, the interior part of the body being provided with a right-angled circular groove which brings about a sharp deviation of the gases, an increased depression thus beng created and the Coanda effect then being obtained on a Coanda polyhedral profile consisting of a number of steps which are correlated with one another by certain angles and different lengths the ratio of which varies between 8 and 0.1, steps which form in the interior of the body a convergent-divergent nozzle joined thereafter to a diffuser having fixed at its other extremity a burner head in the interior of which are mounted a deflector provided with a number of radial vanes, a disc with orifices, and a flame stablizer, likewise having a number of orifices.

4230 Marine Engineering

REFER ALSO TO CITATION(S) 28987

4240 Pollution Control Equipment

REFER ALSO TO CITATION(S) 28865, 28868

4250 Power Cycles

REFER ALSO TO CITATION(S) 29798

30167 **(SERI/CP—234-1577, pp 87-97) State-of-the-art of heat engines.** Smith, J.L. Jr. (Massachusetts Inst. of Tech., Cambridge). 1981. NTIS, PC A11/MF A01.

From Thermo regenerative electrochemical systems workshop; Alexandria, VA, USA (3 Dec 1981).

Topics include heat engine fundamentals, energy flow and entropy flow, requirements for a good engine, fuel engines, and Stirling engines. (WHK)

43 PARTICLE ACCELERATORS

4301 Design, Development, And Operation

REFER ALSO TO CITATION(S) 30909, 30957

30168 **(DOE/ER/10569—T2) Collective acceleration of ions using high-current relativistic-electron beams. Annual technical progress report.** (Cornell Univ., Ithaca, NY (USA). Lab. of Plasma Studies). [nd]. Contract AC02-80ER10569. 19p. NTIS, PC A02/MF A01. Order Number DE83010918.

The work carried out in this program uses a relativistic electron beam as the acceleration medium for protons, with energy transfer accomplished through large amplitude waves grown on and carried by the beam. The wave accelerator has potential for staging so that its use extends, not only to low or intermediate energy applications, but also to systems needing high energy beams. This type of system has recently become more attractive as a result

of the development of magnetic modulator techniques for the highly efficient generation of short duration, high repetition rate pulses. The work reported here has been primarily aimed at the development of an accelerator system for demonstration of the proof-of-principle experiment for proton acceleration in space charge waves carried on an electron beam. It includes efforts to maintain a solid base of fundamental physics experiments exploring the nature of nonlinear space charge wave propagation on electron beams.

30169 **(LA-UR—83-755) Prototype phase and amplitude feedback-control systems for the FMIT accelerator.** Fazio, M.V.; Patton, R.D. (Los Alamos National Lab., NM (USA)). 1983. Contract W-7405-ENG-36. 4p. (CONF-830311—53). NTIS, PC A02/MF A01. Order Number DE83009973.

From Particle accelerator conference; Santa Fe, NM, USA (21 Mar 1983).

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The phase and amplitude feedback-control systems for the Fusion Materials irradiation Test (FMIT) accelerator have been successfully prototyped and tested. The testing was performed at low power with two 100-W rf systems driving a high-Q resonant cavity at 80 MHz. The control systems can maintain the cavity field amplitude to within +-1% and the phase to within +-1° of the set-point values. When there are multiple rf systems independently driving a resonant cavity through individual drive loops, amplitude matching and proper phasing between the outputs of each rf system are essential for proper system operation. Experimental results are presented.

30170 **(LA-UR—83-767) Disk-and-washer linac structure with biperiodic T supports.** Iwashita, Y. (Los Alamos National Lab., NM (USA)). 1983. Contract W-7405-ENG-36. 4p. (CONF-830311—67). NTIS, PC A02/MF A01. Order Number DE83009990.

From Particle accelerator conference; Santa Fe, NM, USA (21 Mar 1983).

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The disk-and-water (DAW) linac structure with particular biperiodic washer-support geometries promises to be an excellent structure for $\beta > 0.5$ accelerator applications. Outstanding features of this structure include high efficiency, high stability, good vacuum properties, and ease of fabrication.

30171 **(LA-UR—83-768) Mechanical features of the ATS RFQ linear accelerator.** Wilson, N.G.; Hayward, T.D.; Lind, G.W. (Los Alamos National Lab., NM (USA)). 1983. Contract W-7405-ENG-36. 4p. (CONF-830311—52). NTIS, PC A02/MF A01. Order Number DE83009991.

From Particle accelerator conference; Santa Fe, NM, USA (21 Mar 1983).

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A radio-frequency quadrupole (RFQ) linear accelerator has been constructed and placed in operation on the Los Alamos National Laboratory accelerator test stand (ATS). This accelerator uses an evacuated rf manifold to distribute rf excitation from the 425-MHz rf power supply to the slot-coupled, RFQ vane-cavity, resonator assembly. The RFQ vanes are supported on commercially available copper-plated, linear, resilient C-seals to provide a high-conductivity rf contact that permits aligning and positioning the vanes during tuning, and demounting the vanes for evaluation and modification as necessary. All rf structures are fabricated from stress-relieved, bright-acid copper-plated carbon steel. Measurements made on the accelerator as assembled have demonstrated >8000 vane-cavity Q at the quadrupole's ~ 423.400-MHz accelerating-mode frequency. Operating manifold vacuum of 3 to 6 x 10^{-8} torr has been observed after rf conditioning; conditioning required 150 h for stable high-power rf operation. Experience to date has indicated the desirability of modifying the vane rf-contact seat configuration to improve assembly and alignment procedures, improving vane-machining processes to increase vane straightness, installing periodic vane-shorting rings to minimize the effect of dipole modes in the quadrupole accelerating structure,and modifying the waveguide-coupling slot in the manifold to improve forward rf power flow.

30172 **Laser-driven electron accelerators.** Palmer, R.B. New York, NY; Institute of Electrical and Electronics Engineers, Inc. (1981). 3370-3374p. Institute of Electrical and Electronics Engineers, Inc. Contract W-7405-ENG-26.

From 1981 particle accelerator conference; Washington, DC, USA (11 Mar 1981).

Several accelerator designs are discussed in search for a greater than 1 TeV electron accelerator. The types considered are linear accelerators, the inverse Cerenkov accelerators, the wiggler (inverse free electron laser), plasma accelerators, and the grating accelerator. A table is given which compares 1 TeV examples for each accelerator. 14 references, 8 figures.

4302 Beam Dynamics, Field Calculations, And Ion Optics

REFER ALSO TO CITATION(S) 30118, 30224, 30234, 30253, 30254, 30263

30173 **(ANL-HEP-CP—82-40) Beam-strahlung effects in e-p collider.** Cho, Y. (Argonne National Lab., IL (USA)). Sep 1982. Contract W-31-109-ENG-38. 3p. (CONF-8206116—29). NTIS, PC A02/MF A01. Order Number DE83009433.

From DPF summer study on elementary particle physics and future facilities (APS); Aspen, CO, USA (28 Jun 1982).

The electromagnetic fields produced by one beam in an interaction point of a colliding-beam facility cause to the emission of synchrotron radiation by the other beam. This effect, the beam strahlung, for the $e+e^-$ colliders has been considered by several authors, and they have pointed out that the effect is very important consideration at very-high-energy $e+e^-$ colliders. At the first glance, the beam-strahlung effect can play an important role in the e-p collision due to the fact that the circulating currents in the collider are much higher than those of the $e+e^-$ machine. However the detailed study shows that is not the case because of the collision geometry involved. What follows in this note is the beam-strahlung derivations using the method previously used by Hofmann and Keil. The difference between this note and that of Hofman and Keil is that in the case of $e+e^-$ collider, equal mass particles are involved in the consideration and, in the e-p case, the electrons radiate and the protons provide the electromagnetic fields.

30174 **(ANL-HEP-CP—83-15) Filters for stochastic cooling of longitudinal beam emittance.** Kramer, S.L.; Konecny, R.; Simpson, J.; Wright, A.J. (Argonne National Lab., IL (USA)). Mar 1983. Contract W-31-109-ENG-38. 3p. (CONF-830311—105). NTIS, PC A02/MF A01. Order Number DE83010756.

From Particle accelerator conference; Santa Fe, NM, USA (21 Mar 1983).

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The shorted stub filter (SSF) has been used extensively to provide the electronics gain shaping for stochastic cooling of longitudinal beam emittance. The repetitive notch of this filter results from the cancellation of the incident signal by the reflected signal at frequencies where the cable electrical length equals an integer number of half wavelengths. Variations in notch depth of the SSF have been approximately compensated by a rather complicated system. Dispersion of the notch frequency resulting from variation of the phase velocity can also be approximately corrected using tuned imperfections in the shorted cable. Dispersion due to imperfections in the coaxial cable can be quite significant and can only be compensated for by costly construction techniques. This paper describes another type of notch filter. Although this filter has been mentioned previously, this analysis demonstrates the advantages of this filter in providing small notch dispersion and other properties necessary for stochastic cooling systems. Because this filter uses only forward signals, it is quite insensitive to imperfections in cables and components, and can therefore be constructed from commercially available components.

30175 (BNL—32728) End fields of CBA superconducting magnets. Kirk, H.G.; Herrera, J.; Willen, E. (Brookhaven National Lab., Upton, NY (USA)). 1983. Contract AC02-76CH00016. 4p. (CONF-830311—99). NTIS, PC A02/MF A01. Order Number DE83010435.

From Particle accelerator conference; Santa Fe, NM, USA (21 Mar 1983).

Measurements of the two dimensional harmonic content of the end fields generated by the Brookhaven CBA dipole and quadrupole superconducting magnets are presented. Both the local longitudinal structure and the integrated end effects are examined.

30176 (BNL—32736) Field quality aspects of CBA superconducting magnets. Kahn, S.; Engelmann, R.; Fernow, R.; Greene, A.F.; Herrera, J.; Kirk, H.; Skaritka, J.; Wanderer, P.; Willen, E. (Brookhaven National Lab., Upton, NY (USA)). 1983. Contract AC02-76CH00016. 4p. (CONF-830311—84). NTIS, PC A02/MF A01. Order Number DE83010439.

From Particle accelerator conference; Santa Fe, NM, USA (21 Mar 1983).

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A series of superconducting dipole magnets for the BNL Colliding Beam Accelerator which were manufactured to have the proper field quality characteristics has been tested. This report presents the analysis of the field harmonics of these magnets.

30177 (BNL—32764) Longitudinal instabilities with a non-harmonic rf potential. Krinsky, S.; Wang, J.M. (Brookhaven National Lab., Upton, NY (USA)). 1983. Contract AC02-76CH00016. 4p. (CONF-830311—89). NTIS, PC A02/MF A01. Order Number DE83010428.

From Particle accelerator conference; Santa Fe, NM, USA (21 Mar 1983).

We consider the longitudinal instabilities of a bunched beam subject to a non-harmonic rf potential. Assuming the unperturbed bunch to be described by a Maxwell-Boltzmann distribution, our treatment is based upon the linearized Vlasov equation. The formalism developed is exact, and in particular, correctly describes the effect of the dependence on amplitude of the synchrotron oscillation frequency. We discuss the fast blowup limit, and extend Wang and Pellegrini's treatment of the microwave instability to include the case of a non-Gaussian bunch. Next, within the short bunch approximation, we derive the dispersion relation describing the Landau damping of the coupled bunch modes, resulting from the use of a Landau cavity.

30178 (BNL—32785) Space charge limits in ESQ transport systems. Maschke, A.W.; Brodowski, J.; Meier, E. (Brookhaven National Lab., Upton, NY (USA)). 1983. Contract AC02-76CH00016. 3p. (CONF-830311—95). NTIS, PC A02/MF A01. Order Number DE83010425.

From Particle accelerator conference; Santa Fe, NM, USA (21 Mar 1983).

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This report describes the results obtained in a series of experiments done with a variety of different electrostati quadrupole configurations, using the precision optical bench system.

30179 (BNL—51636) Beam-beam interactions in P-P colliding accelerators. Parzen, G. (Brookhaven National Lab., Upton, NY (USA)). Jan 1983. Contract AC02-76CH00016. 22p. NTIS, PC A02/MF A01. Order Number DE83010383.

Non-linear stop-bands, due to the beam-beam interaction in a P-P colliding accelerator, are computed and used to estimate the strength of the beam-beam interaction. Results for the stop-band widths due to various causes are summarized. These results are used to compare the effects of beam-beam non-linear resonances in the ISR with those in CBA (Colliding Beam Accelerator at BNL), to estimate the effect of a spectrometer magnet placed at one of the beam crossing points, and to compare the beam-beam interactions for colliding beam accelerators with different crossing angles and different β-functions at the crossing points.

30180 (CONF-830311—103) Use of axially symmetric electrostatic fields for ion-beam focussing. Colton, E.; Kelly, J.C. (Argonne National Lab., IL (USA); Arizona State Univ., Tempe (USA)). 1983. Contract W-31-109-ENG-38. 3p. NTIS, PC A02/MF A01. Order Number DE83010709.

From Particle accelerator conference; Santa Fe, NM, USA (21 Mar 1983).

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The 1/r electric field obtained between charged coaxial cylindrical electrodes is useful for focusing hollow ion beams in ion-microprobe and ion- implantation applications. The focusing strengths are mass-independent at nonrelativistic energies. Focused-particle densities can be enhanced by using a diverging-converging pair to flatten the dependence of focal length on incoming-beam radius. Transport of 425-keV and 1-MeV protons has been simulated and results are presented.

30181 (CONF-830311—104) Energy measurement using a resonator-based time-of-flight system. Pardo, R.C.; Lewis, R.N.; Johnson, K.W.; Clifft, B. (Argonne National Lab., IL (USA)). 1983. Contract W-31-109-ENG-38. 3p. NTIS, PC A02/MF A01. Order Number DE83010580.

From Particle accelerator conference; Santa Fe, NM, USA (21 Mar 1983).

The resonant time-of-flight system which has been developed has several advantages over other potential approaches. The system is non-interceptive and nondestructive. The beam phase space is preserved. It is non-dispersive. Path length variations are not introduced into the beam transport which would reduce the timing resolution. It has a large signal-to-noise ratio when compared to non-resonant beam pick-up techniques. It provides the means to precisely set the linac energy and, potentially, to control the energy in a feedback loop is desired. It is less expensive than an equivalent magnetic system.

30182 (FERMILAB/TM—1173) 120-GeV proton transport for antiproton production in the Fermilab Tevatron I project. Colton, E.; Hojvat, C.; Oleksiuk, L. (Argonne National Lab., IL (USA); Fermi National Accelerator Lab., Batavia, IL (USA)). Mar 1983. Contract AC02-76CH03000. 4p. (CONF-830311—43). NTIS, PC A02/MF A01. Order Number DE83009777.

From Particle accelerator conference; Santa Fe, NM, USA (21 Mar 1983).

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Short bunches of 120 GeV protons will be used for the production of 8 GeV antiprotons. Protons will be extracted vertically from the Main Ring using two high field Lambertson type magnets at location F17. The beam transport is made of three sections: horozintol dispersion cancellation, vertical dispersion cancellation and final focusing. The final focusing section is composed of two quadrupole doublets and allows for variation in β^* values at the target from 1.5 m to 20.0 m.

30183 (FERMILAB/TM—1175) Mechanical and electrical design of the Fermilab lithium lens and transformer system. Dugan, G.; Hojvat, C.; Lennox, A.J.; Biallas, G.; Cilyo, F.; Leininger, M.; McCarthy, J.; Sax, W.; Snowdon, S. (Fermi National Accelerator Lab., Batavia, IL (USA)). Mar 1983. Contract AC02-76CH03000. 4p. (CONF-830311—42). NTIS, PC A02/MF A01. Order Number DE83009779.

From Particle accelerator conference; Santa Fe, NM, USA (21 Mar 1983).

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A lithium-lens focusing device will be used for the collection of 8-GeV antiprotons in the Fermilab Tevatron I Project. The details of the mechanical and electrical design of the Fermilab lens and its associated toroidal transformer are discussed. The lens, with a radium of 1 cm and length 15 cm, is expected to achieve gradients of 1000 T/m for a focal distance of 0.225 m. The gradient requires a current on the order of 5×10^5 A, resulting in large electromagnetic and thermal stresses. The power-supply discharge current and the effect of the inductance of the power leads and connections are minimized by the use of a toroidal matching transformer surrounding the lens itself.

30184 **(FERMILAB/TM—1176) Design for antiproton collection and beam transport in the Fermilab Tevatron I project.** Colton, E.; Hojvat, C. (Argonne National Lab., IL (USA); Fermi National Accelerator Lab., Batavia, IL (USA)). Mar 1983. Contract AC02-76CH03000. 4p. (CONF-830311—41). NTIS, PC A02/MF A01. Order Number DE83009778.

From Particle accelerator conference; Santa Fe, NM, USA (21 Mar 1983).

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120-GeV protons from the Main Ring will be used to produce 8-GeV antiprotons. A pulsed lithium lens collects and matches the antiprotons to a beam line for injection into the Debuncher Ring. The anti p beam has a transverse emittance of 20π mm-mr and a $\delta p/p = +\text{-}2.0\%$. The beam line consists of a clean-up section with vertical emittance selection, two long dispersion free sections, a bend and a vertical injector. Antiprotons with a transverse emittance of 2π mm-mr and $\delta p/p = +\text{-}7.0 \times 10^{-4}$ are transported in the reverse direction, bypassing the target area, and along the 120-GeV proton transport line for reverse injection in the Main Ring.

30185 **(JINR—9-81-570) Investigation of inhomogeneities of synchrophasotron magnetic field. On the low intensity beam dynamics.** Beznogikh, Yu.D.; Bonch-Osmolovskij, A.G.; Voevodin, M.A.; Volkov, V.I.; Zinov'ev, L.P.; Kulikov, I.I. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of High Energy). 1981. 14p. (In Russian). NTIS (US Sales Only), PC A02/MF A01. Order Number DE83701522.

The results of measuring magnetic field inhomogeneities of JINR synchrophasotron are presented. A method of handling measurement results to define azimuthal harmonic derivatives of magnetic field is described. For the first time these data permitted to receive a picture of radial and azimuthal dependences of field index "n" and its derivatives up to the third order. The results obtained were used for analysing possible sources of particle losses at accelerating small intensity beams (< or approximately 5×10^{11} part/pulse).

30186 **(LA-UR—83-703) Operating characteristics of a 2.0-MeV RFQ.** Purser, F.O.; Wadlinger, E.A.; Sander, O.R.; Potter, J.M.; Crandall, K.R. (Los Alamos National Lab., NM (USA)). 1983. Contract W-7405-ENG-36. 4p. (CONF-830311—73). NTIS, PC A02/MF A01. Order Number DE83009950.

From Particle accelerator conference; Santa Fe, NM, USA (21 Mar 1983).

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A second radio-frequency quadrupole (RFQ) accelerator has been designed, constructed and operated at Los Alamos National Laboratory. The accelerator's design parameters represent a major extension from the original Los Alamos RFQ, with the new accelerator being 2.5 times as long, having three times the output energy, and with 2.5 times the current limit. The new accelerator's operating characteristics were studied for 3 months before disassembly to incorporate design mofidications. Results are discussed.

30187 **(LA-UR—83-704) Errors in radio-frequency quadrupole structures.** Lysenko, W.P. (Los Alamos National Lab., NM (USA)). 1983. Contract W-7405-ENG-36. 4p. (CONF-830311—72). NTIS, PC A02/MF A01. Order Number DE83009951.

From Particle accelerator conference; Santa Fe, NM, USA (21 Mar 1983).

Performance degradation caused by certain radio-frequency quadrupole (RFQ) machine errors was studied using an efficient 3-D particle-tracing simulation code for a high-brightness example. Matched beams, for which no emittance growth occurs, exist for periodic structures and were used as input beams for particle tracing in the presence of errors. We considered both slowly varying and fast (random) errors that destroy periodicity. Random dipole errors cause emittance growth because of the mismatches they introduce and also result in a motion of the beam centroid that causes a reduction in acceptance. Because of the way RFQs are manufactured, the random error amplitudes can be kept below harmful levels. More important are the slow errors, which are harmful because they reduce acceptance even though they maintain a match (up to the point of particle loss). Slow dipole errors steer the beam toward the wall, and voltage deficiencies cause instabilities in the longitudinal direction resulting in particles not being accelerated to full energy.

30188 **(LA-UR—83-705) Moment approach to charged particle beam dynamics.** Channell, P.J. (Los Alamos National Lab., NM (USA)). 1983. Contract W-7405-ENG-36. 4p. (CONF-830311—71). NTIS, PC A02/MF A01. Order Number DE83009956.

From Particle accelerator conference; Santa Fe, NM, USA (21 Mar 1983).

We have derived the hierarchy of moment equations that describes the dynamics of charged-particle beams in linear accelerators and can truncate the hierarchy at any level either by discarding higher moments or by a cumulant expansion discarding only correlation functions. We have developed a procedure for relating the density expansion linearly to the moments to any order. The relation of space-charge fields to the density has been derived; and an accurate, systematic, and computationally convenient expansion of the resultant integrals has been developed.

30189 **(LA-UR—83-707) Emittance scanner for intense low-energy ion beams.** Allison, P.W.; Sherman, J.D.; Holtkamp, D.B. (Los Alamos National Lab., NM (USA)). 1983. Contract W-7405-ENG-36. 4p. (CONF-830311—81). NTIS, PC A02/MF A01. Order Number DE83009958.

From Particle accelerator conference; Santa Fe, NM, USA (21 Mar 1983).

An emittance scanner has been developed for use with low-energy H^- ion beams to satisfy the following requirements: (1) angular resolution of +-1/2 mrad, (2) small errors from beam space charge, and (3) compact and simple design. The scanner consists of a 10-cm-long analyzer containing two slits and a pair of electric deflection plates driven by a +-500-V linear ramp generator. As the analyzer is mechanically driven across the beam, the front slit passes a thin ribbon of beam through the plates. The ion transit time is short compared with the ramp speed; therefore, the initial angle of the ions that pass through the rear slit is proportional to the instantaneous ramp voltage. The current through the rear slit then is proportional to the phase-space density $d^2i/dxdx'$. The data are computer-analyzed to give, for example, rms emittance and phase-space density contours. Comparison of measured data with those calculated from a prepared (collimated) phase space is in good agreement.

30190 **(LA-UR—83-733) Three-dimensional field program.** Foss, M.H. (Los Alamos National Lab., NM (USA)). 1983. Contract W-7405-ENG-36. 4p. (CONF-830311—82). NTIS, PC A02/MF A01. Order Number DE83009965.

From Particle accelerator conference; Santa Fe, NM, USA (21 Mar 1983).

The high-energy microtrons studied at Argonne National Laboratory (ANL) require complicated magnetic field shapes. A three-dimensional infinite-permeability magnetic field program was written to show that poles and coils can be devised to produce these fields. The program is in Hewlett-Packard 9845B BASIC, which limits the active mesh to about 30,000 points. In some problems the number of useful points can be greatly increased by placing virtual points one plane beyond the active mesh. The program has four parts: (1) prepare the problem description file, (2) load the starting mesh, (3) relax the mesh, and (4) output results. Preliminary results indicate that the magnet edge can be quite hard and suggest that the required field shapes can be produced.

30191 **(LA-UR—83-743) Radio-frequency quadrupole vane-tip geometries.** Crandall, K.R.; Mills, R.S.; Wangler, T.P. (Los Alamos National Lab., NM (USA)). 1983. Contract W-7405-ENG-36. 4p. (CONF-830311—46). NTIS, PC A02/MF A01. Order Number DE83009967.

From Particle accelerator conference; Santa Fe, NM, USA (21 Mar 1983).

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Radio-frequency quadrupole (RFQ) linacs are becoming widely accepted in the accelerator community. They have the remarkable capability of simultaneously bunching low-energy ion

beams and accelerating them to energies at which conventional accelerators can be used, accomplishing this with high-transmission efficiencies and low-emittance growths. The electric fields, used for radial focusing, bunching, and accelerating, are determined by the geometry of the vane tips. The choice of the best vane-tip geometry depends on considerations such as the peak surface electric field, per cent of higher multipole components, and ease of machining. We review the vane-tip geometry based on the ideal two-term potential function and briefly describe a method for calculating the electric field components in an RFQ cell with arbitrary vane-tip geometry. We describe five basic geometries and use the prototype RFQ design for the Fusion Materials Irradiation Test (FMIT) accelerator as an example to compare the characteristics of the various geometries.

30192 **(LA-UR—83-752) Solution to the transverse-phase-space time-dependence problem with LAMPF's high-intensity H^+ beam.** Hurd, J.W. (Los Alamos National Lab., NM (USA)). 1983. Contract W-7405-ENG-36. 3p. (CONF-830311—56). NTIS, PC A02/MF A01. Order Number DE83009970.

From Particle accelerator conference; Santa Fe, NM, USA (21 Mar 1983).

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The 750 keV H^+ beam at LAMPF has a transverse phase-space time-dependent transient during the first 200 μs of each 750-μs-long macro-pulse. The time dependence is documented in an earlier report. Further studies indicate that the time dependence is due to space-charge neutralization resulting from secondary emission of electrons produced by collisions of the H^+ and H_2^+ beams on the transport walls. One of several possible solutions has been tested and has proven successful in eliminating the time dependence of the beam entering the linac.

30193 **(LA-UR—83-849) Intense ion ring acceleration in a flux-compressing liner.** Faehl, R.J.; Gisler, G. (Los Alamos National Lab., NM (USA)). 1983. Contract W-7405-ENG-36. 4p. (CONF-830311—59). NTIS, PC A02/MF A01. Order Number DE83010096.

From Particle accelerator conference; Santa Fe, NM, USA (21 Mar 1983).

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Circular accelerators based upon increasing magnetic flux comprise one of the oldest classes of machines, the betatron being a prime example. We have found that intense, charged neutralized ion rings can be accelerated to interesting energies by imploding a conducting liner on the field/ring configuration. Because the ring radius is not fixed, we find that the energy scaling varies from linear in the field (p/sub θ/^{2} proportional to B/sub z/) at low energies to square root scaling (γ proportional to B/sub z/sup 1/2/) at relativistic energies. Simpe modeling has confirmed many of the characteristics we have seen in 2 1/2-D fully electromagnetic particle simulations.

30194 **(LA-UR—83-850) Self-trapping electron-ring accelerators.** Gisler, G.; Faehl, R. (Los Alamos National Lab., NM (USA)). 1983. Contract W-7405-ENG-36. 3p. (CONF-830311—57). NTIS, PC A02/MF A01. Order Number DE83010097.

From Particle accelerator conference; Santa Fe, NM, USA (21 Mar 1983).

Simulations performed with a fluid MHD extension to the PIC plasma code CCUBE show that it is in principle possible to design liner-driven ring accelerators so that they generate their own trapping well. The liner elements are tapered in mass and respond in a predictable way to the driving acceleration. Currents arise as the liner moves through an imposed axial field, and if the liner shape is appropriate, a magnetic trapping well results. A cusp-injected electron ring is then introduced, trapped, and accelerated to high energies.

30195 **(UCID—19771) Beam-tracking studies with RINGBEARER II.** Masamitsu, J.A.; Yu, S.S.; Chambers, F.W. (Lawrence Livermore National Lab., CA (USA)). 22 Nov 1982. Contract W-7405-ENG-48. 43p. NTIS, PC A03/MF A01. Order Number DE83008907.

This report presents results from the RINGBEARER II linearized monopole/dipole particle simulation for an intense relativistic electron beam propagating in a gas near three types of channels: (1) pre-existing conductivity, (2) density, and (3) density with pre-existing conductivity. Comparisons are made with earlier analytic results for the initial conditions for the pre-existing conductivity channel.

30196 **(UCRL—88264) Beam-dump/diagnostics box for a 10-kA 50-MeV, 50-ns electron beam.** White, J.M.; Fessenden, T.J.; Fontaine, R.A.; Harvey, A.R.; Paul, A.C. (Lawrence Livermore National Lab., CA (USA)). 9 Mar 1983. Contract W-7405-ENG-48. 5p. (CONF-830311—100). NTIS, PC A02/MF A01. Order Number DE83010261.

From Particle accelerator conference; Santa Fe, NM, USA (21 Mar 1983).

We have developed a dump for the ATA beam that consists of a series of carbon plates whose collective thickness totals approximately 1.5 ranges at 50 MeV. The energy dissipated in the plates is radiated to a water-cooled wall. The dump is designed to dissipate up to 175 kW of average power. A small hole along the axis of the plates forms a beamlet that passes through an energy analyzer. The analyzer consists of a 60° bending magnet and two high-sensitivity beam-current/position monitors. The ratio of the beamlet current to full current is used to estimate the beam emittance.

4303 Auxiliaries And Components

REFER ALSO TO CITATION(S) 29268, 29270, 29271, 29273, 29275, 29276, 29277, 29280, 29282, 30096, 30113, 30117, 30143, 30144, 30145, 30182, 30183, 30189, 30252, 30270, 30291, 30293, 30797

30197 (ANL—82-80, pp 1-13) **Progress on the construction of the spallation neutron source at the Rutherford Appleton Laboratory.** Gray, D.A. (Rutherford Appleton Lab., Abingdon, England). Jan 1983. NTIS, PC A99/MF A01.

From 6. annual international collaboration of advanced neutron sources meeting; Argonne, IL, USA (28 Jun 1982).

This paper gives details of progress on the Spallation Neutron Source which is due to produce first neutrons in 1984. It updates similar reports given at ICANS-IV and ICANS-V.

30198 (ANL—82-80, pp 15-40) **Status and neutron scattering experiments at KENS.** Watanabe, N. (National Lab. for High Energy Physics, Oho, Ibaraki, Japan); Sasaki, H.; Ishikawa, Y.; Endoh, Y.; Inoue, K. Jan 1983. NTIS, PC A99/MF A01.

From 6. annual international collaboration of advanced neutron sources meeting; Argonne, IL, USA (28 Jun 1982).

This paper reports present status of the KENS facility, progress in neutron scattering experiments and instrumental developments, and status of the KENS-I' program. A design study of a high intensity rapid-cycle 800 MeV proton synchrotron for proposed new pulsed neutron (KENS-II) and meson source is also descirbed.

30199 (ANL—82-80, pp 41-49) **Status of the SNQ project at KFA Juelich.** Bauer, G.S. (Kernforschungsanlage, Juelich, Germany). Jan 1983. NTIS, PC A99/MF A01.

From 6. annual international collaboration of advanced neutron sources meeting; Argonne, IL, USA (28 Jun 1982).

The study for a high power spallation neutron source carried out jointly by the Kernforschungszentrum Karlsruhe and the Kernforschungsanlage Juelich has been completed in May 1981. In Feb. 1982 the KFA Juelich was selected as the site for a future spallation neutron source in Germany. A final decision about its construction does, however, require more planning work which will be carried out by KFA until the end of 1983. A formal project SNQ has been established at KFA, starting July 1, 1982. A staged concept for the realization of the facility will be studied.

30200 (ANL—82-80, pp 69-76) **Status report on the SIN neutron source.** Fischer, W.E. (Schweizerisches Institut fuer Nuklearforschung, Villigen, Switzerland). Jan 1983. NTIS, PC A99/MF A01.

From 6. annual international collaboration of advanced neutron sources meeting; Argonne, IL, USA (28 Jun 1982).

The present status is as follows: injector II is under construction, improvement of the proton channel for high current operation is in the design stage, and the spallation neutron source design is progressing.

30201 (ANL—82-80, pp 77-104) **Intense pulsed neutron source (IPNS) at Argonne National Laboratory (ANL): a status report as of June, 1982.** Carpenter, J.M.; Potts, C.W.; Lander, G.H. (Argonne National Lab., IL). Jan 1983. NTIS, PC A99/MF A01.

From 6. annual international collaboration of advanced neutron sources meeting; Argonne, IL, USA (28 Jun 1982).

In this status report a general overview is given of the IPNS program. The facility has been operating since August 1981 and in a routine way for outside users since November 1981. The accelerator performance has been exceptional. Most instruments are now operational, or nearly so. For details of the individual instruments and experimental program the reader is referred to papers later in these proceedings.

30202 (ANL—82-80, pp 247-264) **IPNS data acquisition system.** Worlton, T.G.; Crawford, R.K.; Haumann, J.R.; Daly, R. (Argonne National Lab., IL). Jan 1983. NTIS, PC A99/MF A01.

From 6. annual international collaboration of advanced neutron sources meeting; Argonne, IL, USA (28 Jun 1982).

The IPNS Data Acquisition System (DAS) was designed to be reliable, flexible, and easy to use. It provides unique methods of acquiring Time-of-Flight neutron scattering data and allows collection, storage, display, and analysis of very large data arrays with a minimum of user input. Data can be collected from normal detectors, linear position-sensitive detectors, and/or area detectors. The data can be corrected for time-delays and can be time-focussed before being binned. Corrections to be made to the data and selection of inputs to be summed are entirely software controlled, as are the time ranges and resolutions for each detector element. Each system can be configured to collect data into millions of channels. Maximum continuous data rates are greater than 2000 counts/sec with full corrections, or 16,000 counts/sec for the simpler binning scheme used with area detectors. Live displays of the data may be made as a function of time, wavevector, wavelength, lattice spacing, or energy. In most cases the complete data analysis can be done on the DAS host computer. The IPNS DAS became operational for four neutron scattering instruments in 1981 and has since been expanded to seven instruments.

30203 (ANL—82-80, pp 407-429) **Measurement of neutron spectra and fluxes at the IPNS Radiation Effects Facility.** Birtcher, R.C.; Kirk, M.A.; Blewitt, T.H.; Greenwood, L.R. (Argonne National Lab., IL). Jan 1983. NTIS, PC A99/MF A01.

From 6. annual international collaboration of advanced neutron sources meeting; Argonne, IL, USA (28 Jun 1982).

We have measured the neutron spectra, fluxes, and flux distributions produced by nuclear spallation resulting from 478-MeV proton bombardment of tantalum and depleted uranium targets surrounded by a thick lead neutron reflector. The configuration was chosen to simulate a radiation effects facility at a spallation-neutron source. The method of multiple foil activation with spectrum unfolding by the STAYSL computer code was used to measure the neutron spectra. The experimental results are compared in detail with the results of computer calculations on the same configuration of targets and reflector. The neutron production and transport codes HETC and VIM were employed in these calculations. Based on these measurements, the Radiation Effects Facility (REF) was designed and constructed at the IPNS. Using similar activation techniques the neutron spectra, fluxes and flux distributions have been determined for the REF.

30204 (ANL-HEP-CP—82-56) **Workshop on polarized targets and materials. Summary.** Hill, D. (Argonne National Lab., IL (USA)). 1982. Contract W-31-109-ENG-38. 7p. (CONF-8209124—2-Summ.). NTIS, PC A02/MF A01. Order Number DE83009449.

From Workshop on polarized targets and materials; Upton, NY, USA (16 Sep 1982).

Summaries are given of presentations of developments in: irradiated ammonia; polarized atomic hydrogen; polarized target technology; and chemical doping. (GHT)

30205 (BNL—32652) **Quench-protection studies on CBA magnets.** Stevens, A.J.; Cottingham, J.G.; Ghosh, A.; Robins, K.; Sampson, W.B. (Brookhaven National Lab., Upton, NY (USA)). 1983. Contract AC02-76CH00016. 4p. (CONF-830311—94). NTIS, PC A02/MF A01. Order Number DE83010454.

From Particle accelerator conference; Santa Fe, NM, USA (21 Mar 1983).

Results from quench studies on both short-cable samples and prototype Colliding Beam Accelerator project magnets are presented. The quantity of paramount interest is $\int I^2 dt$ which is a monotonic function of the maximum conductor temperature obtained in a quench. Conductor damage in short samples has been observed for $\int I^2 dt \geqq 8.4 \times 10^6$ amp^2-sec at 50 kG and 4.2°K. Each magnet is equipped with spot heaters in various locations so that systematic studies of quench propagation under controlled conditions can be made. Values of $\int I^2 dt$ as a function of current, location, bath temperature, and cooling mode (single-phase helium versus two-phase helium) are presented. The magnets are able to absorb their own energy with a modest margin of safety for the type of quenches expected in an accelerator environment. In order to obtain an additional margin of safety, a quench-protection scheme which employs current shunting diodes across each magnet half has been adopted.

30206 (BNL—32711) **Magnetic properties of the iron laminations for CBA magnets.** Tannenbaum, M.J.; Ghosh, A.K.; Robins, K.E.; Sampson, W.B. (Brookhaven National Lab., Upton, NY (USA)). 1983. Contract AC02-76CH00016. 4p. (CONF-830311—93). NTIS, PC A02/MF A01. Order Number DE83010457.

From Particle accelerator conference; Santa Fe, NM, USA (21 Mar 1983).

The required magnetic properties of the iron for CBA dipoles are for the most part the same as those for conventional accelerators, namely: low coercive force, high permeability at both low and high inductions, and high saturation induction. There are two main differences in the CBA application, (1) the iron is at 3.8°K, and (2) the magnetic field in the iron can go as high as 6 Tesla, which is well above saturation. Measurements of the magnetization curves for CBA iron laminations at 300°K and 4.2°K are presented. The data are analyzed in terms of a simple model in which the variation in saturation induction can be separated from the low field permeability variation. Tolerances on coercive force, permeability, and saturation induction are discussed.

30207 (BNL—32713) **Acceleration of heavy ions in the AGS.** Barton, M.Q. (Brookhaven National Lab., Upton, NY (USA)). 1983. Contract AC02-76CH00016. 2p. (CONF-830311—64). NTIS, PC A02/MF A01. Order Number DE83010147.

From Particle accelerator conference; Santa Fe, NM, USA (21 Mar 1983).

It is possible to use the Brookhaven AGS as a heavy ion machine by adding a cyclotron to the Tandem and using this combination as injector. An intermediate step for lighter ions might consist of injecting the Tandem beam directly into the AGS. In either case, quite high intensities should be possible.

30208 (BNL—32737) **Internal trim coils for CBA superconducting magnets.** Thompson, P.A.; Aronson, S.; Cottingham, J.G.; Garber, M.; Hahn, H.; Sampson, W.B. (Brookhaven National Lab., Upton, NY (USA)). 1983. Contract AC02-76CH00016. 4p. (CONF-830311—83). NTIS, PC A02/MF A01. Order Number DE83010438.

From Particle accelerator conference; Santa Fe, NM, USA (21 Mar 1983).

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In order to correct iron saturation effects and shape the beam working line, superconducting trim coils have been constructed, which operate inside the main coils. Detailed studies of mechanical properties, quench behavior, fields produced, and hysteresis have lead to the production of accelerator-quality coils generating the required-strength harmonics up to cos (7θ). These are routinely installed in CBA main magnets and operate at 80% of short sample with negligible training in an ambient field of more than 5.3T.

30209 **(BNL—32765) Microprocessor techniques and construction at the NSLS.** Klein, J.D.; Sheehan, J.F. (Brookhaven National Lab., Upton, NY (USA)). 1983. Contract AC02-76CH00016. 4p. (CONF-830311—90). NTIS, PC A02/MF A01. Order Number DE83010427.

From Particle accelerator conference; Santa Fe, NM, USA (21 Mar 1983).

A description is given of the microprocessor systems in use at the NSLS, which utilize Intel Multibus and NSLS-developed printed circuit boards. Ease of manufacturing and flexibility of developing different systems from a set of NSLS standard components will be emphasized, and the low cost factors of each system and the utilization of off-the-shelf components will be indicated.

30210 **(BNL—32766) Undulators as sources of synchrotron radiation.**. Krinsky, S. (Brookhaven National Lab., Upton, NY (USA)). 1983. Contract AC02-76CH00016. 6p. (CONF-830311—92). NTIS, PC A02/MF A01. Order Number DE83010434.

From Particle accelerator conference; Santa Fe, NM, USA (21 Mar 1983).

At the present time the first generation of facilities having electron storage rings designed for and dedicated to synchrotron radiation research are beginning operations in the US, Europe and Japan. The use of wigglers and undulators as enhanced sources of synchrotron radiation plays an important role at all these facilities. Moreover, recently there has been much activity in the design of the next generation machines, which will place even greater, and perhaps exclusive, emphasis on the use of wigglers and undulators. The operation of these insertion devices has been made even more attractive by advances in the design and construction of permanent magnet wigglers and undulators. This reliable and economical technology eliminates the need for more complex superconducting magnets, except to achieve very high magnetic fields for the production of hard photons from relatively low energy rings. We review the spectral properties of the radiation, emphasizing the complementary aspects of time- and frequency-domain analyses. We next study the brightness of the undulator source. Finally, we consider some limitations associated with operating an undulator in a storage ring.

30211 **(BNL—32767) Power-supply regulation by microprocessor.** Sheehan, J.; Langenbach, H. (Brookhaven National Lab., Upton, NY (USA)). 1983. Contract AC02-76CH00016. 4p. (CONF-830311—98). NTIS, PC A02/MF A01. Order Number DE83010433.

From Particle accelerator conference; Santa Fe, NM, USA (21 Mar 1983).

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Many small-magnet power supplies are regulated by using a microprocessor system to generate control voltages to continuously servoregulate each power supply. The power supplies are of very simple design since all regulation and feedback hardware are parts of the microprocessor system. Most of the supplies are bipolar transistor followers, powered by a common unregulated dc power supply and are used to power trim steering magnets on the three NSLS synchrotron rings. Twelve-bit accuracy is obtained using commercially available microprocessor pc cards.

30212 **(BNL—32774) Status of the AGS polarized negative-ion source.** Alessi, J.; Kponou, A.; Raymond, R.; Sluyters, T. (Brookhaven National Lab., Upton, NY (USA)). 1983. Contract AC02-76CH00016. 3p. (CONF-830311—91). NTIS, PC A02/MF A01. Order Number DE83010432.

From Particle accelerator conference; Santa Fe, NM, USA (21 Mar 1983).

Development of an intense polarized H^- source for the AGS continues at Brookhaven National Laboratory. Initial tests with about one milliampere, 40 keV pulsed neutral cesium beam, colliding with more than two milliampere polarized hydrogen atoms, produced about one-half microampere polarized negative ions, extracted at 20 keV. A new pulsed cesium source with an anticipated output of 5 to 15 mA and an improved neutralizer are under construction.

30213 **(BNL—32776) Broadband accelerator control network.** Skelly, J.; Clifford, T.; Frankel, R. (Brookhaven National Lab., Upton, NY (USA)). 1983. Contract AC02-76CH00016. 3p. (CONF-830311—101). NTIS, PC A02/MF A01. Order Number DE83010431.

From Particle accelerator conference; Santa Fe, NM, USA (21 Mar 1983).

A broadband data communications network has been implemented at BNL for control of the Alternating Gradient Synchrotron (AG) proton accelerator, using commercial CATV hardware, dual coaxial cables as the communications medium, and spanning 2.0 km. A 4 MHz bandwidth Digital Control channel using CSMA-CA protocol is provided for digital data transmission, with 8 access nodes available over the length of the RELWAY. Each node consists of an rf modem and a microprocessor-based store-and-forward message handler which interfaces the RELWAY to a branch line implemented in GPIB. A gateway to the RELWAY control channel for the (preexisting) AGS Computerized Accelerator Operating system has been constructed using an LSI-11/23 microprocessor as a device in a GPIB branch line. A multilayer communications protocol has been defined for the Digital Control Channel, based on the ISO Open Systems Interconnect layered model, and a RELWAY Device Language defined as the required universal language for device control on this channel.

30214 **(BNL—32781) Conversion of the AGS linac to H^- acceleration.** Witkover, R.L.; Barton, D.S.; Reece, R.K. (Brookhaven National Lab., Upton, NY (USA)). 1983. Contract AC02-76CH00016. 4p. (CONF-830311—97). NTIS, PC A02/MF A01. Order Number DE83010437.

From Particle accelerator conference; Santa Fe, NM, USA (21 Mar 1983).

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The AGS 200 MeV linac was converted to an H^- accelerator during the summer of 1982 using a magnetron-type source in the column of the second pre-injector pit. Because of the re-entrant electrode design, a 20 keV transport line was required to carry the beam to the first electrode. Several changes were made to the source which enhanced its performance over previous designs. The same H^- beam current is available at 2.75 times the duty factor with reduced deterioration of its output over several months of operation. The source, 750 keV transport, and linac modifications and performance will be presented.

30215 **(BNL—32784) Charge exchange injection at the AGS.** Barton, D.S.; Ahrens, L.A.; Gill, E.; Glenn, J.W.; Reece, R.K.; Witkover, R.L. (Brookhaven National Lab., Upton, NY (USA)). 1983. Contract AC02-76CH00016. 4p. (CONF-830311—102). NTIS, PC A02/MF A01. Order Number DE83010426.

From Particle accelerator conference; Santa Fe, NM, USA (21 Mar 1983).

The AGS has been brought into operation in October 1982 with multi-turn H^- charge exchange injection. The injection area of the AGS has been modified to bring the H^- beam from the 200 MeV linac through the main magnet fringe field to a stripping foil located within the magnet aperture. The injection system is described in detail and initial performance of the accelerator is reported.

30216 **(BNL—32787) Single bunch transfer system for the National Synchrotron Light Source.** Sheehan, J.; Singh, O.; Rambo, W. (Brookhaven National Lab., Upton, NY (USA)). 1983. Contract AC02-76CH00016. 4p. (CONF-830311—96). NTIS, PC A02/MF A01. Order Number DE83010424.

From Particle accelerator conference; Santa Fe, NM, USA (21 Mar 1983).

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The accelerator system at the National Synchrotron Light Source consists of an S-band 85 MeV linac and three synchrotron rings. The electron beam from the linac is accelerated by the booster ring to 600 MeV and transferred to one of the two storage rings. The smaller of the two rings operates between 300 and 800 MeV emtting photons in the vacuum ultraviolet (VUV), while the larger storage ring operates up to 2.5 GeV and emits photons in the x-ray spectrum. A system is described for loading the storage rings by filling a single-phase space bunch in the booster ring and transferring it at the end of each booster cycle into a selected bucket in one of the storage rings. By controlling the timing of the transfer on successive transfer cycles, many fill patterns may be obtained.

30217 **(BNL—32806) Superconductivity and future accelerators.** Danby, G.T.; Jackson, J.W. (Brookhaven National Lab., Upton, NY (USA)). 1963. Contract AC02-76CH00016. 4p. (CONF-830311—85). NTIS, PC A02/MF A01. Order Number DE83010441.

From Particle accelerator conference; Santa Fe, NM, USA (21 Mar 1983).

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For 50 years particle accelerators employing accelerating cavities and deflecting magnets have been developed at a prodigious rate. New accelerator concepts and hardware ensembles have yielded great improvements in performance and GeV/$. The great idea for collective acceleration resulting from intense auxiliary charged-particle beams or laser light may or may not be just around the corner. In its absence, superconductivity (SC) applied both to rf cavities and to magnets opened up the potential for very large accelerators without excessive energy consumption and with other economies, even with the cw operation desirable for colliding beams. HEP has aggressively pioneered this new technology: the Fermilab single ring 1 TeV accelerator - 2 TeV collider is near the testing stage. Brookhaven National Laboratory's high luminosity pp 2 ring 800 GeV CBA collider is well into construction. Other types of superconducting projects are in the planning stage with much background R & D accomplished. The next generation of hadron colliders under discussion involves perhaps a 20 TeV ring (or rings) with 40 TeV CM energy. This is a very large machine: even if the highest practical field B ~ 10T is used, the radius is 10x that of the Fermilab accelerator. An extreme effort to get maximum GeV/$ may be crucial even for serious consideration of funding.

30218 **(BNL—32829) Status of the National Synchrotron Light Source.** Galayda, J.N. (Brookhaven National Lab., Upton, NY (USA)). 1983. Contract AC02-76CH00016. 4p. (CONF-830311—86). NTIS, PC A02/MF A01. Order Number DE83010445.

From Particle accelerator conference; Santa Fe, NM, USA (21 Mar 1983).

The status and performance of the NSLS 700 MeV ring and 2.5 GeV ring are described. Emphasis is placed on properties of the stored beam pertinent to synchrotron radiation production, the factors determining these properties, and efforts to improve performance of the rings.

30219 **(BNL—32856) Tests for pulsed high-current heavy-ion synchrotron injection with an MP-Tandem Van de Graaff.** Thieberger, P.; McKeown, M.; Wegner, H.E. (Brookhaven National Lab., Upton, NY (USA)). 1983. Contract AC02-76CH00016. 4p. (CONF-830311—87). NTIS, PC A02/MF A01. Order Number DE83010444.

From Particle accelerator conference; Santa Fe, NM, USA (21 Mar 1983).

The new MARK VII high-current negative-heavy-ion source designed by R. Middleton was operated in a pulsed mode to provide 100 to 200 μa negative-ion currents in 230-μsec square pulses, 10/sec. These pulses, 50 to 100 times more intense than normal dc beams, were then accelerated by the MP7 Tandem Van de Graaff accelerator while operating at 14 MV. After charge-state analysis, the emittance of the pulsed beam was also measured. The very stable accelerator behavior indicated that even higher currents are possible. Values for ^{16}O are: 115 μa $^{16}O^-$ injected, 100-MeV $^{16}O^{6+}$, 260 μa (43.3 pμa) 1.8 mm.mr; and for ^{32}S are: 170 μa $^{32}S^-$ injected, 140-MeV $^{32}S^{9+}$, 240 μa (26.7 pμa) 0.51 mm.mr. The high intensity and low emittance of these ion beams make them ideal for injection into a synchrotron like the AGS 30 GeV proton accelerator at BNL.

30220 **(BNL—32874) High-energy gamma-ray beams from Compton-backscattered laser light.** Sandorfi, A.M.; LeVine, M.J.; Thorn, C.E.; Giordano, G.; Matone, G. (Brookhaven National Lab., Upton, NY (USA)). 1983. Contract AC02-76CH00016. 6p. (CONF-830311—88). NTIS, PC A02/MF A01. Order Number DE83010443.

From Particle accelerator conference; Santa Fe, NM, USA (21 Mar 1983).

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Collisions of light photons with relativistic electrons have previously been used to produce polarized γ-ray beams with modest (-10%) resolution but relatively low intensity. In contrast, the LEGS project (Laser + Electron Gamma Source) at Brookhaven will produce a very high flux ($>2 \times 10^7$ s^{-1}) of background-free polarized γ rays whose energy will be determined to a high accuracy ($\Delta E = 2.3$ MeV). Initially, 300(420)-MeV γ rays will be produced by backscattering uv light from the new 2.5(3.0)-GeV X-ray storage ring of the National Synchrotron Light Source (NSLS). The LEGS facility will operate as one of many passive users of the NSLS. In a later stage of the project, a Free Electron Laser is expectred to extend the γ-ray energy up to 700 MeV.

30221 **(CONF-810314—193) Determination of transverse phase-space and momentum error from size measurements along the 50-MeV H^- RCS injection line.** Cho, Y.; Crosbie, E.A.; Takeda, H. (Argonne National Lab., IL (USA)). 1981. Contract W-31-109-ENG-38. 3p. NTIS, PC A02/MF A01. Order Number DE83008854.

From Particle accelerator conference; Washington, DC, USA (11 Mar 1981).

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The 50-MeV H^- injection line for the RCS at Argonne National Laboratory has 16 quadrupole and eight bending magnets. Horizontal and vertical profiles can be obtained at 12 wire scanner positions. Size information from these profiles can be used to determine the three ellipses parameters in each plane required to describe the transverse phase space. These locations that have dispersion permit the momentum error to be used as a fourth fitting parameter. The assumed accuracy of the size measurements provides an error matrix that predicts the rms errors of the fitted parameters.

30222 **(CONF-830311—65) Coupled operation experience at the Holifield Heavy-Ion research Facility.** Lord, R.S.; Ball, J.B.; Hudson, E.D.; Kloeppel, P.K.; Ludemann, C.A.; Martin, J.A.; Mosko, S.W.; Ziegler, N.F. (Oak Ridge National Lab., TN (USA)). 1983. Contract W-7405-ENG-26. 3p. NTIS, PC A02/MF A01. Order Number DE83010142.

From Particle accelerator conference; Santa Fe, NM, USA (21 Mar 1983).

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The 25URC Pelletron tandem electrostatic accelerator and the Oak Ridge Isochronous Cyclotron (ORIC) comprise the accelerators of the Holifield Heavy-Ion Research Facility (HHIRF). The two machines may be operated individually or coupled, with ORIC serving as an energy booster for the tandem. In the coupled dode, the ion beam enters the cyclotron through the dee stem and is directed by the inflection magnet so that it is tangent to an orbit suitable for acceleration at a higher charge state. A thin carbon foil, placed at the point of tangency, strips the ions so that a substantial fraction are in the desired higher charge state. This fraction of the beam is then accelerated and extracted in the normal fashion. Full energy performance (25 MeV/A oxygen) was demonstrated during first coupled operation in January 1981. Routine coupled operation for experiments commenced in July 1982.

30223 (CONF-8110271—1) Argonne National Laboratory 1980-1981 tandem-linac accelerator report. Hartog, P.D.; Pardo, R.; Munson, F.; Heath, C. (Argonne National Lab., IL (USA)). 1981. Contract W-31-109-ENG-38. 6p. NTIS, PC A02/MF A01. Order Number DE83010601.

From Symposium on northeastern accelerator personnel; Ontario, Canada (14 Oct 1981).

Performance of the facility is discussed. The FN tandem Van de Graaff is now used as an injector for the superconducting linac; heavy-ion beams are being injected. Stripper foil development is described, with fabrication by arc evaporation and by RF discharge compared. Facility modifications, such as the control room, are discussed. (GHT)

30224 (LA-UR—83-660) Pulsed air-core deflector-magnet design parameters. Jason, A.J.; Cooper, R.K.; Liebman, A.D.; Blind, B.; Koelle, A.R. (Los Alamos National Lab., NM (USA)). 1983. Contract W-7405-ENG-36. 4p. (CONF-830311—60). NTIS, PC A02/MF A01. Order Number DE83009977.

From Particle accelerator conference; Santa Fe, NM, USA (21 Mar 1983).

The response of air-core magnets to pulsed excitation is dependent on the pulse frequency spectrum because of fields produced by induced currents in the magnet structure. We discuss this phenomenon quantitatively in terms of magnet performance optimization.

30225 (LA-UR—83-702) Time-jitter reduction on the rf buncher signal for the Los Alamos Proton Storage Ring (PSR). Higgins, E.F.; Paffenroth, G.G. (Los Alamos National Lab., NM (USA)). 1983. Contract W-7405-ENG-36. 4p. (CONF-830311—69). NTIS, PC A02/MF A01. Order Number DE83009979.

From Particle accelerator conference; Santa Fe, NM, USA (21 Mar 1983).

The multiplier described in this paper is part of a considerably larger system whose function is to generate several synchronizing signals for the PSR. Without examining the details, the larger sync system must, from a basic 201.25-MHz clock rate, generate phase-coherent, low-noise cw signals of 2.795 MHz for the LF buncher, 100.625 MHz for low-precision timing, and 16.77 MHz for the prebuncher in addition to the 503.125-MHz HF buncher described above. In very general terms, implementing these requirements involved dividing the 201.25-MHz clock rate by 72 to obtain 2.795 MHz and multiplying this rate by 6 to obtain 16.77 MHz using techniques very similar to those described in this paper.

30226 (LA-UR—83-717) FMIT accelerator. Armstrong, D.D. (Los Alamos National Lab., NM (USA)). 1983. Contract W-7405-ENG-36. 6p. (CONF-830311—79). NTIS, PC A02/MF A01. Order Number DE83009960.

From Particle accelerator conference; Santa Fe, NM, USA (21 Mar 1983).

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A 35-MeV 100-mA cw linear accelerator is being designed by Los Alamos for use in the Fusion Materials Irradiation Test (FMIT) Facility. Essential to this program is the design, construction, and evaluation of performance of the accelerator's injector, low-energy beam transport, and radio-frequency quadrupole sections before they are shipped to the facility site. The installation and testing of some of these sections have begun as well as the testing of the rf, noninterceptive beam diagnostics, computer control, dc power, and vacuum systems. An overview of the accelerator systems and the performance to date is given.

30227 (LA-UR—83-718) Imagescope to photodiode beam-profile imaging system. Chamberlin, D.D.; Hollabaugh, J.S.; Stump, C.J. Jr. (Los Alamos National Lab., NM (USA)). 1983. Contract W-7405-ENG-36. 4p. (CONF-830311—78). NTIS, PC A02/MF A01. Order Number DE83009961.

From Particle accelerator conference; Santa Fe, NM, USA (21 Mar 1983).

Transverse beam-distribution measurements of high-current cw accelerators must be obtained from noninterceptive sensors. For the 100-mA H_3 or D beam of the Fusion Materials Irradiation Tst (FMIT) accelerator, these transverse properties may be obtained by detecting the visible radiation resulting from beam interactions with residual gas. A system of mirrors, intensified TV cameras, digitizers, and topographic reconstruction codes has been reported previously. This report describes a new technique for sensing and digitizing the light projected transversely from the beam of the FMIT accelerator at Los Alamos National Laboratory.

30228 (LA-UR—83-719) Los Alamos Proton Storage Ring (PSR) injection deflector system. Jason, A.j.; Higgins, E.F.; Koelle, A.R. (Los Alamos National Lab., NM (USA)). 1983. Contract W-7405-ENG-36. 4p. (CONF-830311—77). NTIS, PC A02/MF A01. Order Number DE83009962.

From Particle accelerator conference; Santa Fe, NM, USA (21 Mar 1983).

We describe a pulsed magnetic deflector system planned for the injection system of the PSR. Two sets of magnets, appropriately placed in the optical systems of both the ring and the injection transport line, provide control of the rate at which particles are injected into a given portion of transverse phase space and limit the interaction of stored beam with the injection stripping foil. High-current modulators that produce relatively complex waveforms are required for this purpose. Solid-state drivers using direct feedback to produce the necessary waveforms are discussed as replacements for the more conventional high-voltage tube technology.

30229 (LA-UR—83-720) Pulsed beam chopper for the PSR at LAMPF. Lunsford, J.S.; Hardekopf, R.A. (Los Alamos National Lab., NM (USA)). 1983. Contract W-7405-ENG-36. 4p. (CONF-830311—75). NTIS, PC A02/MF A01. Order Number DE83009963.

From Particle accelerator conference; Santa Fe, NM, USA (21 Mar 1983).

A traveling-wave beam chopper has been designed to provide properly structured negative-ion beam to the Proton Storage Ring (PSR) and other LAMPF users. The chopper must provide a 20-mrad kick with pulse rise time <5 ns for the 750-keV H^- ions in the injector transpoft line. Variable pulse lengths from 15 ns to 750 μs at repetition rates up to 16.7 MHz must be generated in synchronization with the PSR circulation frequency. Parameter studies led to an optimized design combining good deflection efficiency and bandwidth with minimum deleterious effects from plate-to-plate coupling. Both positive and negative 600-V pulses, with lengths up to 1 ms and maximum 10% duty factor, can be generated to drive the deflectors.

30230 (LA-UR—83-734) rf system for the Los Alamos free-electron laser (FEL). Friedrichs, C.C.; Tallerico, P.J.; Hoffert, W.J. (Los Alamos National Lab., NM (USA)). 1983. Contract W-7405-ENG-36. 4p. (CONF-830311—47). NTIS, PC A02/MF A01. Order Number DE83009966.

From Particle accelerator conference; Santa Fe, NM, USA (21 Mar 1983).

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The FEL electron linac consists of three buncher cavities: two accelerator cavities and a deflection cavity, each with its own phase-coherent rf source. All sources will be pulsed for 100 μs at a 1-pps rate. The phase and amplitude stability requirements are +-1/2°, and +-1/2%. There are two subharmonic bunchers, each requiring 5 kW at 108.33 MHz. All remaining cavities operate at 1300 MHz. The fundamental buncher requires 5 kW, whereas each of the accelerating cavities requires at least 3 MW. The deflection cavity requires up to 100 kW, which is coupled from one of the accelerator cavity rf sources. Prominent features of the rf system are the phase and amplitude control circuits and the multimegawatt klystron amplifiers. Three L3707 klystrons were obtained from the AMRAD radar site at White Sands, which was decommissioned in the early 1970s. The tubes originally were designed to produce 10-MW, 10-μs pulses. Each tube has delivered over 3.6-MW, 100-μs pulses in the FEL system.

30231 (LA-UR—83-744) Data-acquisition software for the LAMPF control system. Schaller, S.C.; Rose, P.A. (Los Alamos National Lab., NM (USA)). 1983. Contract W-7405-ENG-36. 9p. (CONF-830311—45). NTIS, PC A02/MF A01. Order Number DE83009968.

From Particle accelerator conference; Santa Fe, NM, USA (21 Mar 1983).

As part of the upgrade of the Los Alamos Meson Physics Facility (LAMPF) control computer, the software providing the interface between application programs and the accelerator hardware was redesigned. This new Data System design - which handles more than 12,000 widely different devices - allows greater uniformity, flexibility, maintainability, and hardware independence than before. The Data System portion of the LAMPF Control System is described in this paper.

30232 **(LA-UR—83-753) Performance tests of the 600-kW, cw, 80-MHz, radio-frequency systems for the FMIT accelerator.** Nylander, R.F.; Fazio, M.V.; Bacci, F.F.; Rogers, J.D. (Los Alamos National Lab., NM (USA)). 1983. Contract W-7405-ENG-36. 4p. (CONF-830311—55). NTIS, PC A02/MF A01. Order Number DE83009971.

From Particle accelerator conference; Santa Fe, NM, USA (21 Mar 1983).

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The high-power rf system for the Fusion Materials Irradiation Test (FMIT) accelerator consists of 14 sets of equipment, each of which can deliver up to 600 kW (cw) at 80 MHz into a load having a VSWR of 1.4 or less (any phase). The equipment was designed and constructed to FMIT specifications by Continental Electronics Manufacturing Co. (CEMC) of Dallas, Texas. Four sets have been shipped to Los Alamos for use with the accelerator (two with the radio-frequency quadrupole (RFQ) and two with the drift-tube linac (DTL)). The first set was fully tested at CEMC. Further tests conducted at Los Alamos, both into a resistive (electrolytic) load and into a resonant cavity (Q ~ 21,000), have confirmed that this system meets, and in most cases far exceeds, the specified performance limits. The first of the 13 production sets (No. 5) also was tested at CEMC before shipping any of the rf equipment to the Hanford Engineering and Development Laboratory at Richland, Washington. Because of the differences in behavior observed when No. 1 was operated at Los Alamos with a different tube installed in the final power amplifier (FPA) cavity, CEMC agreed to test No. 5 with two tubes having widely differing characteristics (notably primary screen emission). As expected, behavior differed markedly, and some design modification was necessary to meet all specifications with either tube. Results of final performance tests on No. 5 are summarized. Discussion of the most significant aspects of CEMC's tests and of those performed at Los Alamos follows a brief description of the equipment.

30233 **(LA-UR—83-754) Laser photoionization of H^0 beams for charge-changing injection.** Blind, B.; Jason, A.J. (Los Alamos National Lab., NM (USA)). 1983. Contract W-7405-ENG-36. 4p. (CONF-830311—54). NTIS, PC A02/MF A01. Order Number DE83009972.

From Particle accelerator conference; Santa Fe, NM, USA (21 Mar 1983).

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The two-step charge-changing injection used in the Los Alamos Proton Storage Ring (PSR) requires stripping of H^- to H^0 by high magnetic fields and subsequent stripping of H^0 to H^+ by a carbon foil. We consider single- and multiphoton laser ionization as alternatives to using a fragile foil. The multiphoton case is of possible interest for selection of practical lasers, which tend to have increased power output at higher wavelengths. The formulas derived express the necessary laser powers for ionization of monoenergetic H^0 beams; they also hold for beams of particles other than atomic hydrogen. The numerical examples given are for the 800-MeV PSR beam with momentum spread taken into account. Additionally, we discuss selective stripping as an implication of the inherent energy selectivity of the photoionization process.

30234 **(LA-UR—83-757) Sequential bunch extractions in the Los Alamos PSR.** Wang, T.F.; Cooper, R.K.; Smith, L. (Los Alamos National Lab., NM (USA)). 1983. Contract W-7405-ENG-36. 4p. (CONF-830311—50). NTIS, PC A02/MF A01. Order Number DE83009975.

From Particle accelerator conference; Santa Fe, NM, USA (21 Mar 1983).

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In the short-bunch, high-frequency operating mode of the future Proton Storage Ring (PSR) at LAMPF the extraction scheme will take out one bunch at a time. Because the ring only stores six bunches at most and because the bunching system is heavily beam loaded, each extraction can cause a substantial change in the average beam current and hence affects significantly the total bunching voltage as well as the phase synchronization between those remaining bunches and the voltage waveform. A time-dependent cavity-tuning scheme has been considered to retain the proper bunching voltage and phase relation. This work examines the stability of the phase synchronization in the transient stage of extraction and cavity tuning. An equivalent circuit model is adopted, and the coupled nonlinear differential equations are solved numerically. We find that the relative phase will remain stable and that the voltage variation is tolerable under the PSR proposed operating conditions. A comparison between the numerical and analytical solutions confirms the numerical results.

30235 **(LA-UR—83-766) Computer modeling of the klystron.** Tallerico, P.J.; Carlsten, B.E. (Los Alamos National Lab., NM (USA)). 1983. Contract W-7405-ENG-36. 4p. (CONF-830311—68). NTIS, PC A02/MF A01. Order Number DE83009989.

From Particle accelerator conference; Santa Fe, NM, USA (21 Mar 1983).

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Although the klystron was invented over 40 years ago, it still is quite a scientific challenge to analyze this seemingly simple device. Accurate calculation of space-charge density and particle motions are required, but there are dozens of parameters that must be optimized. Thus the analysis must be inexpensive to run, because over 100 runs typically are required to optimize a particular design. A self-consistent ring model of the klystron interaction is being developed for use as a design tool, with the initial goal of improving the LAMPF klystrons to conserve electrical energy. A mathematical model that includes large-signal effects, relativity, harmonic and fundamental cavities, extended cavity fields, and self-consistent calculations of the induced currents is being developed. The model is self-consistent because the gap fields are calculated interactively, because the currents that drive the cavities are not known until after the beam transverses the cavities. Several test cases have been run, and the basic theory and results to date are discussed.

30236 **(LA-UR—83-811) Radiation-hardened field coils for FMIT quadrupoles.** Grieggs, R.J.; Liska, D.J.; Harvey, A. (Los Alamos National Lab., NM (USA)). 1983. Contract W-7405-ENG-36. 4p. (CONF-830311—61). NTIS, PC A02/MF A01. Order Number DE83010089.

From Particle accelerator conference; Santa Fe, NM, USA (21 Mar 1983).

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Modern accelerators of the Fusion Materials Irradiation Test (FMIT) class deliver enormous power onto their targets. The high beam currents of such machines produce highly activating radiation fields from beam/target interaction and normal beam losses. The 100-mA deuteron beam from the FMIT accelerator produces a backstreaming fast-neutron flux of 10^{11} n/s-cm^2 near the target. In addition, the neutron contribution from distributed beam spill of 3 μA/m along the rest of the machine prevents the use of epoxy resin potting materials in all magnet field coils above 10-MeV beam energies. Two special techniques for radiation-hardened field coils have been developed at Los Alamos for use on the FMIT accelerator. One technique uses vitreous enamel coatings on the conductors and appears attractive for the drift-tube quadrupoles. Another method uses a thermally efficient two-layer coil design that has solid mineral-insulated (MI) conductors with indirect cooling coils, all bonded together in a lead matrix. Test results are discussed, along with applications of the quadrupoles in the FMIT facility that reduce gamma exposures during maintenance periods.

30237 **(LA-UR—83-828) Wide-bandwidth test fixture for electromagnetic-beam sensors.** Gilpatrick, J.D.; Sherwood, B.A.; Hahn, J.; Chamberlin, D.D. (Los Alamos National Lab., NM (USA)). 1983. Contract W-7405-ENG-36. 4p. (CONF-830311—49). NTIS, PC A02/MF A01. Order Number DE83010000.

From Particle accelerator conference; Santa Fe, NM, USA (21 Mar 1983).

The Fusion Materials Irradiation Test (FMIT) accelerator will supply the neutron flux required for studying materials that may be used in a fusion environment. The diagnostic measurement instrumentation, which will characterize the accelerator beam, must be noninterceptive because of the beam's power density. Instrumentation also must be fully functional for start up of the FMIT accelerator. To this end, three types of test facility were proposed: (1) a low-energy electron accelerator, (2) a large electron-gun assembly, and (3) a coaxial structure that produces electromagnetic fields similar to that of the proposed FMIT accelerator. The third type was chosen. This paper describes the design and some experimental results of the coaxial test fixture.

30238 **(LA-UR—83-844) PHERMEX electron gun development.** Builta, L.A.; Elliott, J.C.; Moir, D.C.; Starke, T.P.; Vecere, C.A. (Los Alamos National Lab., NM (USA)). 1983. Contract W-7405-ENG-36. 4p. (CONF-830311—58). NTIS, PC A02/MF A01. Order Number DE83010081.

From Particle accelerator conference; Santa Fe, NM, USA (21 Mar 1983).

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The PHERMEX facility is a 50-MHz standing-wave linear accelerator. Electrons are injected, accelerated, and transported to a tungsten target where bremsstrahlung x rays are generated for flash radiography of hydrodynamic systems. The purpose of this article is to describe the progress of PHERMEX electron gun development. The goal of this program is to generate and transport a 200-ns, 1-MV, 1-kA electron beam into the first PHERMEX accelerating cavity. The standard gun is operated at a pulse voltage of 550 kV, which is the limit determined by internal breakdown of the vacuum insulator. This insulator has been redesigned, and the gun has been pulsed at 750 kV without internal breakdown. At present, the current output is not limited by voltage but by a phenomenon called pulse shortening, which occurs at a pulse voltage of approximately 650 kV. The phenomenon has been investigated and the results are presented.

30239 **(LA-UR—83-955) Monitor 1983.** Grisham, D.L.; Lambert, J.E. (Los Alamos National Lab., NM (USA)). 1983. Contract W-7405-ENG-36. 4p. (CONF-830311—63). NTIS, PC A02/MF A01. Order Number DE83009907.

From Particle accelerator conference; Santa Fe, NM, USA (21 Mar 1983).

The Monitor remote handling system was especially developed to perform in situ remote maintenance operations on Line A at the Clinton P. Anderson Meson Facility (LAMPF). Previous papers have traced the development of the system from prototype unit thru the more sophisticated Monitor I and Monitor II systems now in use. The Monitor I and Monitor II systems have served well in performing all necessary maintenance; however, future major improvements and expansion of experimental facilities call for development of a third system. Monitor III is a more portable system which will be able to support major disassembly and reconstruction of facilities remote from Line A. The system will include a large trailer mounted cask for safe transport of obsolete radioactive beam line components to the disposal site.

30240 **(LA-UR—83-956) Graphite targets at LAMPF.** Brown, R.D.; Grisham, D.L. (Los Alamos National Lab., NM (USA)). 1983. Contract W-7405-ENG-36. 4p. (CONF-830311—62). NTIS, PC A02/MF A01. Order Number DE83009908.

From Particle accelerator conference; Santa Fe, NM, USA (21 Mar 1983).

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Rotating polycrystalline and stationary pyrolytic graphite target designs for the LAMPF experimental area are described. Examples of finite element calculations of temperatures and stresses are presented. Some results of a metallographic investigation of irradiated pyrolytic graphite target plates are included, together with a brief description of high temperature bearings for the rotating targets.

30241 **(SAND—83-0162) D-T neutron generator development for cancer therapy: 1982 annual progress report.** Bacon, F.M.; Walko, R.J.; Brainard, J.P.; O'Hagan, J.B.; Riedel, A.A. (Sandia National Labs., Albuquerque, NM (USA)). Feb 1983. Contract AC04-76DP00789. 56p. NTIS, PC A04/MF A01. Order Number DE83010393.

The feasibility of the design and operation of a D-T neutron generator for use in cancer therapy has been demonstrated. The principal components of the sealed, non-pumped neutron source would consist of two low-pressure ion sources, each capable of delivering a 200 mA ion beam, a water-cooled scandium target and a 170 kV single-stage accelerator. The final design of the neutron source would be a dual ion source, dual ion beam system to deliver a 400 mA mixed beam of deuterium and tritium ions on the ScDT target and produce 14 MeV neutrons at a rate of 1 to 2 x 10^{13}/s with a lifetime of 100h. All of the feasibility studies have been conducted with deuterium to avoid the health hazards associated with the use of tritium. D-D neutrons were produced at a rate of 7 x 10^{10}/s with a 170 kV/150 mA ion beam and 1 x 10^{11}/s with a 200 kV/200 mA ion beam. These output rates scale to 7 x 10^{12}/s and 1 x 10^{13}/s for D-T operation. Target lifetime of 100h has beeen demonstrated. A new ion source has been developed to operate at a pressure of 0.25 Pa and deliver a 200 mA deuterium ion beam consisting of over 50 percent atomic ions.

30242 **(SLAC-PUB—3082) Status of the SLAC Linear Collider Project.** Stiening, R. (Stanford Linear Accelerator Center, CA (USA)). 1983. Contract AC03-76SF00515. 2p. (CONF-830311—15). NTIS, PC A02/MF A01. Order Number DE83009883.

From Particle accelerator conference; Santa Fe, NM, USA (21 Mar 1983).

The SLAC Linear Collider Project has two principal goals. The first is to serve as a prototype for a future very high energy linear electron-positron collider. The second is to quickly, at low cost, achieve sufficient luminosity at 100 GeV center-of-mass energy to explore the physics of the Z^0. The first goal is important to the future of electron-positron physics because the rapid increase of synchrotron radiation with energy causes the cost of circular storage ring colliders to whereas the cost of linear colliders increases only in proportion to the center-of-mass energy. The second is important because the existance at SLAC of a linear accelerator which can be converted at low cost to collider operation makes possible a unique opportunity to quickly achieve 100 GeV center-of-mass collisions. At the design luminosity of 6.0 x 10^{30} many thousands of Z^0 decays should be observed in each day of operation.

30243 **Fermilab tevatron five refrigerator system tests.** Rode, C.; Ferry, R.; Leiniger, M.; Makara, J.; Misek, J.; Mizicko, D.; Richied, D.; Theilacker, J. (Fermi National Accelerator Lab., Batavia, IL). *Advances in Cryogenic Engineering;* **27**: 549-556(1982). (CONF-810835—).

From 1981 cryogenic engineering conference; San Diego, CA, USA (10 Aug 1981).

The Fermilab Tevatron refrigeration system is described with the layout illustrated. The compressor control loops, the refrigerator control loops, and magnet control loops (two per refrigerator) are described and each illustrated. The mobile purifier is described. A five refrigerator test is presented, using two compressor buildings, satellite refrigerator concept test and the test current to the writing. The configuration of the five refrigerator test is diagramed.

30244 **Cooling the Argonne National Laboratory superconducting heavy-ion linac with two refrigerators in parallel.** Nixon, J.M.; Bollinger, L.M. (Argonne National Lab., Argonne, IL). *Advances in Cryogenic Engineering;* **27**: 579-586(1982). (CONF-810835—).

From 1981 cryogenic engineering conference; San Diego, CA, USA (10 Aug 1981).

The Argonne Superconducting Heavy Ion Linac is described with appropriate history and illustration, including a side view of a cryostat. Linac components are given with totals and approximate heat loads. The helium flow system is described with a plan view of superconducting linac cryostates and helium distribu-

tion system diagrammed. Additions to the cryogenic system are outlined, including the extension of the main helium distribution line, phase separator and transfer lines, and model 2800 refrigerator and compressors. The operating experience is reported with apposite examples.

30245 **Fermilab tevatron transfer line.** Rode, C.; Ferry, R.; Leininger, M.; Makara, J.; Richied, D.; Theilacker, J. (Fermi National Accelerator Lab., Batavia, IL). *Advances in Cryogenic Engineering;* 27: 709-776(1982). (CONF-810835—).

From 1981 cryogenic engineering conference; San Diego, CA, USA (10 Aug 1981).

The Tevatron refrigeration system is described, specifically the design transfer line cross-section. A cross-section and one section Tevatron feed line are illustrated. One pair of Tevatron U-tubes and the transfer line test layout are also illustrated. The fabrication and installation are described. Cooldown and warmup tests are reported with the operation and heat leak measurements given. Current work includes flow instabilities. Preliminary results indicate that heat loads are similar to previous measurements.

30246 **A 50-T/M superconducting quadrupole magnet for a polarized proton beam facility.** Smith, R.P.; Bywater, J.A.; Coover, K.P.; Gonczy, J.D.; Hoffman, J.A.; Kim, S.H.; Niemann, R.C.; Rezmer, R.R.; Underwood, D.A. (ANL, Argonne, IL). *Advances in Cryogenic Engineering;* 27: 105-108(1982). (CONF-810835—).

From 1981 cryogenic engineering conference; San Diego, CA, USA (10 Aug 1981).

This study continues the previous presentation of the development and the design features of the high-gradient quadrupole magnet at Fermilab. The winding shape of the poles was modified; design characteristics of the quadrupole are itemized. The prototype magnet results are given. The magnet tests support the calculated results that the magnet is completely safe during certain described quenches. Field quality measurements are detailed.

30247 **Preparation of self-supporting holmium targets.** Scheu, K.W. (Lawrence Berkeley Lab., Univ. of Calif., Berkeley, CA 94720). pp 159-168 of Preparation of nuclear targets for particle accelerators. Jaklovsky, J. New York, NY; Plenum (1981).

A technique for producing thin self-supporting (150 to 500 $\mu g/cm^2$) /sup 165/ Ho targets on a 1 in. diameter target holder by vacuum evaporation using an electron bombarding source is described.

30248 **The Fermilab Tevatron.** Teng, L.C. (Fermi National Accelerator Lab., Batavia, IL 60510). pp 43-62 of Gauge theories, massine neutrinos, and proton decay. Kursunoglu, B.; Perlmutter, A. New York, NY; Plenum (1981).

From Orbis scientiae conference; Fort Lauderdale, FL, USA (19 Jan 1981).

This article is a report on the status of the Fermilab Tevatron Project. The various phases of the project are described, and the experimental possibilities provided by them are discussed. First priority has been given to the construction of a superconducting magnet synchotron which is capable of accelerating particles to one TeV. Secondly, the project involves the construction of facilities for fixed target experiments at those energies. Finally, the Tevatron will be equipped to perform colliding proton-antiproton experiments.

30249 **NSLS dipole power source.** Bagley, G.P. (Brookhaven National Lab., Upton, NY). *PESC Record, IEEE Power Electronics Specialists Conference;* 308-315(1980).

An SRC DC to DC converter is described which will operate at an output of 275 kW and will supply current to electron storage ring magnets requiring 5 hr stability of 50 ppM. The operation of this modified chopper is described and design equations are presented, along with the system control loop description.

30250 **(CAPE—2817) SLAC down stream waveguide bend (X-5) (Engineering Materials).** (Stanford Linear Accelerator Center, CA (USA)). [nd]. Contract AC03-76SF00515. USDOE-TIC, PO Bx 62, Oak Ridge, TN 37830.

7 35 MM aperture cards.

Drawings SA-767-342-06-R2 and listed related and referenced drawings thereon provide the information and specifications for constructing a typical waveguide bend. This particular one is for a specific location along the Stanford Two-Mile Linear Accelerator. The techniques and construction can be applied to need that is similar. This piece of waveguide is one of many in the rf power distribution system on SLAC's accelerator. Power is conducted from the Klystron Amplifiers thru the vacuum waveguide system to the inputs of the 960 disc loaded waveguide accelerator sections along the Two-Mile length of the Stanford Two-Mile Linear Accelerator.

30251 **(CAPE—2816) SLAC 10 ft accelerator section cooling tube assembly (Engineering Materials).** (Stanford Linear Accelerator Center, CA (USA)). [nd]. Contract AC03-76SF00515. USDOE-TIC, PO Bx 62, Oak Ridge, TN 37830.

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Drawing AD-751-053-00-R2 and listed and referenced drawings thereon provide the information and specifications for constructing a typical water cooling system and attaching it to a typical SLAC 10 ft accelerator section. These cooling tubes are used to carry away excess heat during operation of the accelerator and to provide a stable, fixed temperature (and also dimension) during standby or off time. Nominal temperature is 113°F with allowances being made during operation, for differential temperatures.

4304 Storage Rings

REFER ALSO TO CITATION(S) 30173, 30225, 30229

30252 **(BNL—32678) Free electron laser experiment at Brookhaven.** Luccio, A.; Pellegrini, C.; van Steenbergen, A.; Yue, L.H. (Brookhaven National Lab., Upton, NY (USA)). 1982. Contract AC02-76CH00016. 7p. (CONF-821203—4). NTIS, PC A02/MF A01. Order Number DE83010160.

From International conference on lasers; New Orleans, LA, USA (13 Dec 1982).

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The status of the free electron laser experiment at Brookhaven is reported. We describe the permanent magnet undulator already built and ready to be installed on the VUV storage ring. We also describe the gain measurement experiment now being prepared.

30253 **(BNL—32793) Some remarks on performance of very-high-energy colliders.** Courant, E.D. (Brookhaven National Lab., Upton, NY (USA); State Univ. of New York, Buffalo (USA)). 1983. Contract AC02-76CH00016. 3p. (CONF-830134—3). NTIS, PC A02/MF A01. Order Number DE83010423.

From Orbis scientiae conference; Miami, FL, USA (17 Jan 1983).

A discussion on how the luminosity in a very large p-anti p storage ring scales with the magnetic field of the ring magnets, among other parameters, is given. (WHK)

30254 **(LA-UR—83-585) Rapidly tuned buncher structure for the Los Alamos Proton Storage Ring (PSR).** Earley, L.M.; Lawrence, G.P.; Potter, J.M. (Los Alamos National Lab., NM (USA)). 1983. Contract W-7405-ENG-36. 4p. (CONF-830311—66). NTIS, PC A02/MF A01. Order Number DE83009938.

From Particle accelerator conference; Santa Fe, NM, USA (21 Mar 1983).

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In the PSR's short-bunch operating mode, accumulated beam currents are intense and change rapidly. The resonant frequency of the 503.125-MHz buncher used in this mode must be rapidly adjusted through a 100-kHz range to maintain the correct 90° phase relation between cavity voltage and beam current. Modulation rates are up to 3 kHz/μs. Each structure consists of two side-coupled buncher cavities, resonantly coupled to a ferrite-loaded

tuner cavity. The needed frequency change Δf in the buncher cells is produced by a 50 x Δf change in the tuner, accomplished by varying a magnetic field applied to the ferrite perpendicular to the rf magnetic field. Fast modulation of this bias is provided by a low-inductance ferrite-core magnet excited by a special function generator. The resonantly coupled multicavity structure configuration allows buncher and tuner cells to be independently optimized for their specific functions. This paper describes the buncher design, ferrite selection, and test results from a prototype ferrite-loaded tuner cavity. The tests have demonstrated the tuning scheme's feasibility, showing that the necessary 5-MHz range can be attained with only 12% of the tuner cell filled with ferrite, and that losses in the ferrite are small throughout this frequency interval.

30255 **(LA-UR—83-721) Proton Storage Ring control system.** Clout, P.; Bair, S.; Conley, A.; Ford, R.; Fuka, M.; Greene, N. (Los Alamos National Lab., NM (USA)). 1983. Contract W-7405-ENG-36. 4p. (CONF-830311—74). NTIS, PC A02/MF A01. Order Number DE83009964.

From Particle accelerator conference; Santa Fe, NM, USA (21 Mar 1983).

When designing a control system for a new facility, one is faced with a bewildering array of electronic devices to use in the solution. There is, of course, no single correct solution because the constraints are Laboratory- and project-dependent. The major constraint applicable to the hardware choice for the Proton Storage Ring (PSR) control system was the limited manpower available for the design, development, and documentation of custom hardware. As a result, wherever possible, commercial components have been used that are based on recognized standards. The array of choice on the hardware side contrasts markedly with the absence of suitable commercial software products, and it is unfortunate that here there seems to be little prospect of change. The analysis of the overall system that follows will lead to a suitable hardware choice and a description of the software's structure. This paper is an overview, but more information is available.

30256 **Study on the conditions required for the transverse stability of a coasting beam in proton storage rings.** Cornacchia, M.; Pellegrini, C. (Brookhaven National Lab., Upton, NY (USA)). *Particle Accelerators;* **12**: No. 3, 147-168(Oct 1982).

The transverse stability of coasting beams in proton storage rings has been studied under general assumptions on the shape of the working line (tune versus momentum) and on the momentum distribution function. The impedance model includes space-charge, resistive, and broad-band impedance contributions for an on-axis and an off-axis beam. The effect of space-charge distortion of the working line has also been investigated. The case of the stability in ISABELLE was examined and compared to that in ISR.

30257 **"Magcool"-the production cooling facility for Isabelle magnets.** Bamberger, J.A.; Afrashteh, M.; Brown, D.P.; Schneider, W.J.; Sonderick, J.H.; Wu, K.C. (Brookhaven National Lab., Upton, NY). *Advances in Cryogenic Engineering;* **27**: 533-540(1982). (CONF-810835—).

From 1981 cryogenic engineering conference; San Diego, CA, USA (10 Aug 1981).

The refrigeration system, called "MAGCOOL", is described. This system is designed to test and measure all magnets for ISABELLE at their 3.8 K operating temperature, before their installation in the tunnel. There are over one thousand superconducting magnets to guide the particle beams in two circular rings, 3.8 km in circumference used by the ISABELLE proton accelerator. The system functions are described with detailed block diagram. The pump and purge procedure is described with equipment for the pump and purge itemized. Cooldown I and II are described, with the "MAGCOOL" Low temperature flow schematic given. Test and measure are discussed, as well as the warm-up and instrumentation involved. The system has been checked out and the beginnings of "MAGCOOL" applications software installed. Future operators have been trained at the keyboard and have accepted this more modern form of control.

30258 **Cycle design for the Isabelle helium refrigerator.** Brown, D.P.; Moore, R.W.; Schlafke, A.P.; Wu, K.C. (Brookhaven National Lab., Upton, NY). *Advances in Cryogenic Engineering;* **27**: 501-508(1982). (CONF-810835—).

From 1981 cryogenic engineering conference; San Diego, CA, USA (10 Aug 1981).

The cycle schematic for the ISABELLE Refrigerator with a simplified load is given. The subcooler section is described with a summary on the performance requirements shown with system parameters itemized. The main refrigerator uses a Claude-type cycle which is described along with detail design. State variables at each process point in the cycle are shown with flow properties and flow rates. The refrigerator is scheduled for completion and testing in 1983.

30259 **Design of 24.8-kw, 3.8-K cryogenic system for Isabelle.** Brown, D.P.; Afrashteh, M.; Bamberger, J.A.; Fresco, A.; Schlafke, A.P.; Schneider, W.J.; Sondericker, J.H.; Werner, A.; Wu, K.C. (Brookhaven National Lab, Upton, NY). *Advances in Cryogenic Engineering;* **27**: 509-516(1982). (CONF-810835—).

From 1981 cryogenic engineering conference; San Diego, CA, USA (10 Aug 1981).

The ISABELLE Helium refrigerator is described in terms of performance requirements. Overall design is presented in discussion of the main refrigerator, subcooler/circulation system, distribution and load matching, design heat load, ratio of refrigeration capactity to heat load, system design pressure, physical plant, reliability and redundancy, and process control. The primary and shield circuits for one accelerator ring is diagramed. Isabelle's heat load allowance is given in a table showing primary (W at 4K) and secondary (W at 55K) loads. The redundant components in Isabelle's cryogenic system are illustrated.

30260 **Analysis of cooldown performance for Isabelle helium refrigerator.** Wu, K.C.; Brown, D.P.; Moore, R.W. (Brookhaven National Lab., Upton, NY). *Advances in Cryogenic Engineering;* **27**: 525-532(1982). (CONF-810835—).

From 1981 cryogenic engineering conference; San Diego, CA, USA (10 Aug 1981).

The cooldown performance for the ISABELLE Helium refrigerator is analyzed in terms of the relationship between refrigerator and its load. The flow diagram for ISABELLE with its redundant turbines and heat exchangers is given. Cycle description and procedure for cooldown is described with the relationship between a refrigerator and its load illustrated. Pressure vs. temperature for ISABELLE load and the efficiency for a turbine are illustrated. The procedure for modeling the refrigerator and the concepts of maximizing the cooldown capacity are described. The results and discussion are accompanied with T-S diagrams for initial stage of cooldown and refrigerator characteristic at various return temperatures. The ISABELLE refrigerator with its reduncant expanders properly used achieves cooldown capacity well beyond its steady-state capacity. The cooldown rate at this stage relies on the design safety margin, which for the ISABELLE is 50%.

44 INSTRUMENTATION

30261 **Dual surface interferometer.** Parduc, R.M.; Williams, R.R. (to Dept. of Energy). US Patent 4,334,778. 15 Jun 1982. Filed date 12 Sep 1980. vp.

PAT-APPL-186870.

A double-pass interferometer is provided which allows direct measurement of relative displacement between opposed surfaces. A conventional plane mirror interferometer may be modified by replacing the beam-measuring path cube-corner reflector with an additional quarter-wave plate. The beam path is altered to extend to an opposed plane mirrored surface and the reflected beam is placed in interference with a retained reference beam split from dual-beam source and retroreflected by a reference cube-corner reflector mounted stationary with the interferometer housing. This permits direct measurement of opposed mirror surfaces by laser interferometry while doubling the resolution as with a conventional double-pass plane mirror laser interferometer system.

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REFER ALSO TO CITATION(S) 29298, 29551, 29572, 29614, 30511, 30733, 30786, 30996

30262 **(AERE-MPD/NBS—194) Program TXRES - convolution of sharp excitation cross-section with triple-axis resolution function.** Haywood, B.C.; Hutchings, M.T.; Stringfellow, M.W. (UKAEA Atomic Energy Research Establishment, Harwell. Materials Physics Div.). Dec 1981. 10p. NTIS (US Sales Only), PC A02/MF A01. Order Number DE83701534.

The program TXRES can be used to calculate the intensity at points on a triple-axis spectrometer scan by evaluating a convolution integral to determine the sharp excitation spectrum with no intrinsic broadening. Having described the program, subroutines called in the program, the use of the program, input date, output, availability, storage, and CPU time taken, are explained.

30263 (ANL—81-85-Pt.1, pp 104-105) **High transmission lens for quadrupole mass spectrometry.** Spence, D. Dec 1982. NTIS, PC A08/MF A01.

In ¸Radiological and Environmental Research Division annual report: fundamental molecular physics and chemistry, October 1980-September 1981.

A compound lens system is described which provides for constant focal lengths as the on extraction field, and hence the ion input energy to the lens is varied. This enables a quadrupole mass spectrometer to have constant transmission to improve resolution. (GHT)

30264 (ANL—82-65-Pt.2, pp 93-96) **Instrumentation for collecting and measuring radon and its daughters.** Essling, M.A.; Hengde, W.; Markun, F.; Toohey, R.E.; Rundo, J.; Miranda, J.E. Jr. Nov 1982. NTIS, PC A11/MF A01.

In Radiological and Environmental Research Division, Center for Human Radiobiology. Annual report, July 1981-June 1982.

A new sampling can is described for collecting an air sample for determination of its radon content. Instruments which are employed for the continuous monitoring of radon or its daughters in houses are described and their performances discussed.

30265 (ANL—82-80, pp 115-124) **IPNS time-of-flight single crystal diffractometer.** Schultz, A.J.; Teller, R.G.; Williams, J.M. (Argonne National Lab., IL). Jan 1983. NTIS, PC A99/MF A01.

From 6. annual international collaboration of advanced neutron sources meeting; Argonne, IL, USA (28 Jun 1982).

The single crystal diffractometer (SCD) at the Argonne Intense Pulsed Neutron Source (IPNS) utilizes the time-of-flight (TOF) Laue technique to provide a three-dimensional sampling of reciprocal space during each pulse. The instrument contains a unique neutron position-sensitive ^{6}Li-glass scintillation detector with an active area of 30 x 30 cm. The three-dimensional nature of the data is very useful for fast, efficient measurement of Bragg intensities and for the studies of superlattice and diffuse scattering. The instrument was designed to achieve a resolution of 2% or better ($R = \Delta Q/Q$) with $2\Theta > 60^{\circ}$ and $\lambda > 0.7$A.

30266 (ANL—82-80, pp 157-170) **eV neutron spectroscopy using resonance absorption energy selection on a pulsed source.** Williams, W.G.; Penfold, J. (Rutherford Appleton Lab., Abingdon, England). Jan 1983. NTIS, PC A99/MF A01.

From 6. annual international collaboration of advanced neutron sources meeting; Argonne, IL, USA (28 Jun 1982).

A method is proposed for measuring excitation energies up to ~ 1 eV by using an absorption foil difference technique in the inverse geometry. The discussion is restricted to using the ^{149}Sm resonance at an energy E/sub R/ = 0.873 eV and utilizes other fixed absorption filters to improve the sensitivity of the method for inelastic measurements. Feasibility tests have been carried out on the LAD total scattering spectrometer at the Harwell Linac. By extrapolating from results obtained for ZrH_2 it is predicted that with more powerful sources such as the SNS it should be possible to observe high energy magnetic excitations.

30267 (ANL—82-80, pp 171-177) **Polarized epithermal neutron spectrometer at KENS.** Kohgi, M. (Tohoku Univ., Sendai, Japan). Jan 1983. NTIS, PC A99/MF A01.

From 6. annual international collaboration of advanced neutron sources meeting; Argonne, IL, USA (28 Jun 1982).

A spectrometer employing a white, epithermal, polarized neutron beam is under construction at KENS. The neutron polarization is achieved by passage through a dynamically polarized proton filter (DPPF). The results of the test experiments show that the DPPF method is promising in obtaining polarized epithermal neutron beam. The basic design of the spectrometer is described.

30268 (ANL—82-80, pp 237-246) **Linear position sensitive neutron detector using fiber optic encoded scintillators.** Davidson, P.L.; Wroe, H. (Rutherford Appleton Lab., Abingdon, England). Jan 1983. NTIS, PC A99/MF A01.

From 6. annual international collaboration of advanced neutron sources meeting; Argonne, IL, USA (28 Jun 1982).

A linear position sensitive slow neutron detector with 3 mm resolution is described. It uses the fiber optic coding principle in which the resolution elements are separate pieces of lithium loaded glass scintillator each coupled by means of flexible polymer optical fibers to a unique combination of 3 photo multipliers (PM's) out of a bank of 12. A decoder circuit repsponds to a triple coincidence between PM outputs and generates a 12 bit work which identifies the scintillator element which stopped the incident neutron. Some details of the construction and decoding electronics are given together with test results obtained using a laboratory isotope neutron source and a monochomated, collimated neutron beam from a reactor. The count rate in the absence of neutron sources is 2 to 3 c min^{-1} per element; the element to element variation in response to a uniform flux is a few percent for 95% of the elements; the resolution as measured by a 1 mm wide prode neutron beam is 3 mm; the relative long term stability is about 0.1% over 3 days and the detection efficiency measured by comparison with an end windowed, high pressure gas counter is about 65% at a neutron wavelength of 0.9A°.

30269 (ANL—82-80, pp 291-298) **Inelastic rotor spectrometer at the Harwell Linac.** Boland, B.C. (Rutherford Appleton Lab., Abingdon, England). Jan 1983. NTIS, PC A99/MF A01.

From 6. annual international collaboration of advanced neutron sources meeting; Argonne, IL, USA (28 Jun 1982).

The spectrometer is designed to measure energy transfer from 50 MeV to 400 MeV covering a range of Q values from 1 to 15 A^{-1}. Particular emphasis has been placed on the low Q counter banks where measurements at low Q reduce multiphonon contributions in vibrational spectra, diffusional broadening in liquids and allow measurements to be made on magnetic excitations. All indications are that the energy resolution is as predicted and is certainly twice as good as that of any other spectrometer presently available to the UK users at these energy transfers. Backgrounds on the high angle banks 24° to 94° are excellent but at the low angles are too high at present for anything but hydrogenous samples. Tests have shown that much of this background comes from the main beam in the area of the collimation between the chopper and the sample, and steps are being taken to improve this area.

30270 **(ANL-HEP-CP—82-01) High resolution spectrometer.** Derrick, M. (Argonne National Lab., IL (USA)). 1981. Contract W-31-109-ENG-38. 35p. (CONF-8111151—1). NTIS, PC A03/MF A01. Order Number DE83009689.

From 2. workshop on detectors for TRISTAN; Tsukuba, Japan (16 Nov 1981).

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The High Resolution Spectrometer (HRS) is a general purpose solenoidal spectrometer, the first phase of which has recently been completed. The detector is now installed in Interaction Region 6 at PEP. The first data was taken in the PEP beams late in 1981 during and just subsequent to this workshop. In this talk I will emphasize the considerations that lead us to build the present detector and discuss some of the technical and political trade-offs that were necessary. Since we have yet to report any high energy physics data, the correctness of these decisions is something that will be

judged by the future referees of the Physical Review Letters. (WHK)

30271 (ANL-HEP-CP—82-03) Soudan nucleon decay program. Ayres, D.S. (Argonne National Lab., IL (USA)). 1981. Contract W-31-109-ENG-38. 37p. (CONF-8110269—1). NTIS, PC A03/MF A01. Order Number DE83009600.

From Workshop on physics and astrophysics with a multikiloton underground track-detector; Rome, Italy (29 Oct 1981).

The Soudan nucleon decay program is being carried out in the Soudan iron mine in northeastern Minnesota, at a depth of 2000 m of water equivalent. A 30-ton prototype experiment, Soudan 1, has been built and is now being operated by a University of Minnesota - Argonne National Laboratory collaboration. The detector is a block of iron-loaded concrete instrumented with 3456 gas proportional tubes. It can detect nucleon decay at the 2 x 10^{30} year level, and will measure cosmic-ray induced backgrounds. Soudan 1 is also obtaining data on very high energy cosmic-ray interactions. Monte-Carlo predictions of performance have been checked by calibration of a detector module in a charged-particle test beam. A proposal to build a 1000-ton experiment, Soudan 2, has been submitted to funding agencies in the USA and the UK by a Minnesota - Argonne - Oxford University collaboration. The proposed detector utilizes drift chambers with 50-cm drifts to obtain very fine-grained ionization and tracking information at low cost. This tracking-calorimeter detector has a fiducial mass of 650 tons, and could be operating in 1985. A drifting scheme utilizing 50 cm x 5 m x 1 cm planar chambers has been shown feasible, and prototypes of alternate drifting structures are also being studied. A plan to provide expandability to an eventual 5000 tons has been developed.

30272 (ANL-HEP-CP—82-34) Electrodeless drift chambers with 50-cm drift distance. Ayres, D.S.; Price, L.E. (Argonne National Lab., IL (USA)). Aug 1982. Contract W-31-109-ENG-38. 4p. (CONF-8206116—27). NTIS, PC A02/MF A01. Order Number DE83009518.

From DPF summer study on elementary particle physics and future facilities (APS); Aspen, CO, USA (28 Jun 1982).

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The electrodeless drift-chamber technique is potentially very useful in applications requiring the drifting of ionization in gas over long distances in narrow channels. Chamber construction is simple and cheap; the technique is well suited to very large detectors operating in low-rate environments. Prototype tests on planar chambers reveal excellent drifting characteristics after the initial charging, but show a substantial degradation of pulse height from cosmic rays over a two-week period. The loss of efficiency appears to be caused by excess charge buildup on the dielectric surfaces of the chamber. Several solutions are suggested.

30273 (ANL-HEP-CP—82-49) Development and performance of a calibration system for a large calorimeter array. Arenton, M.; Dawson, J.; Ditzler, W.R. (Argonne National Lab., IL (USA); Fermi National Accelerator Lab., Batavia, IL (USA); Rice Univ., Houston, TX (USA); Pennsylvania Univ., Philadelphia (USA)). 1982. Contract W-31-109-ENG-38. 5p. (CONF-821011—49). NTIS, PC A02/MF A01. Order Number DE83009447.

From IEEE nuclear science symposium; Washington, DC, USA (20 Oct 1982).

Experiment 609 at Fermilab is a study of the properties of high-p/sub t/ collisions using a large segmented hadron calorimeter. The calibration and monitoring of such a large calorimeter array is a difficult undertaking. This paper describes the systems developed by E609 for automatic monitoring of the phototube gains and performance of the associated electronics.

30274 (BNL—32718) Concept of a solid-state drift chamber. Gatti, E.; Rehak, P. (Brookhaven National Lab., Upton, NY (USA)). Mar 1983. Contract AC02-76CH00016. 3p. (CONF-830224—1). NTIS, PC A02/MF A01. Order Number DE83010436.

From DPF workshop on collider detectors: present capabilities and future possibilities; Berkeley, CA, USA (28 Feb 1983).

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The operation of a solid state drift chamber is described, and its use in a high rate, high multiplicity environment is discussed. The Solid State Drift Chamber (SSDCH) is a thin wafer of a high purity n-type silicon (few cm^2 x a few hundreds μm thick) with a single small-area, small-capacitance anode readout. The drift voltage is supplied to an array of drift electrodes on both sides of the wafer to produce a uniform drift field parallel to the surface of the wafer and to ensure the complete depletion of the wafer. (WHK)

30275 (CEA-N—2269) Development of photocathodes for gas counters. Chalot, J.F. (Paris-6 Univ., 75 (France); CEA Centre d'Etudes Nucleaires de Saclay, 91 - Gif-sur-Yvette (France)). Mar 1982. 148p. (In French). NTIS (US Sales Only), PC A07/MF A01. Order Number DE83700393.

A lot of ways of physics needs the development of high sensitivity imaging devices with large sensitive surface. The problems brought by the building of such devices may be solved by the use of gaz counters. But we must sensitize these counters to low energy photons (< 10 eV). We have particularly studied the response of solid state photocathodes working directly into the counter. We show first a method to increase the quantum efficiency of photocathodes. We experiment this method and take few conclusions. We also show a method to measure the photoelectric threshold of a metal under gas and we apply this method. Because of the limitations of our apparatus we have built a system which permits manufacturing and measuring photocathodes. This apparatus which has numerous possibilities and an automatic data taking system are described. We also describe results of its exploitation and the type of investigation that we are going to develop.

30276 (CONF-811012—70) Light-stabilized photomultiplier detector assembly with pulse- and current-mode operation. Fergus, R.W. (Argonne National Lab., IL (USA)). 1981. Contract W-31-109-ENG-38. 4p. NTIS, PC A02/MF A01. Order Number DE83010783.

From IEEE symposium on nuclear science; San Francisco, CA, USA (21 Oct 1981).

This unit was developed to provide an economical scintillator detector assembly for microprocessor-controlled effluent-monitoring systems. The integral high voltage supply is controlled to maintain constant photomultipiler gain fom a pulsed light-emitting diode reference source. This control method also provides current-mode operation if high radiation levels are present. In addition, a simple comparison of the light-output pulse gives an assurance of detector operation.

30277 (CONF-811012—71) Area radiation monitor at the intense pulsed-neutron source. Eichholz, J.J.; Lynch, F.J.; Mundis, R.L.; Howe, M.L.; Dolecek, E.H. (Argonne National Lab., IL (USA)). 1981. Contract W-31-109-ENG-38. 5p. NTIS, PC A02/MF A01. Order Number DE83010699.

From IEEE symposium on nuclear science; San Francisco, CA, USA (21 Oct 1981).

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A tissue-equivalent ionization chamber with associated circuitry has been developed for area radiation monitoring in the Intense Pulsed-Neutron Source (IPNS) facility at Argonne National Laboratory. The conventional chamber configuration was modified in order to increase the electric field and effective volume thereby achieving higher sensitivity and linearity. The instrument provides local and remote radiation level indications and a high level alarm. Twenty-four of these instruments were fabricated for use at various locations in the experimental area of the IPNS-1 facility.

30278 (FEI—1215) Gravitational neutron spectrometer. Grigor'ev, Yu.V. (Gosudarstvennyj Komitet po Ispol'zovaniyu Atomnoj Ehnergii SSSR, Obninsk. Fiziko-Ehnergeticheskij Inst.). 1981. 17p. (In Russian). NTIS (US Sales Only), PC A02/MF A01. Order Number DE83700394.

The new type of a gravitational neutron spectrometer for the energy range E=0.001-1 eV is described. The neutron energy determination is performed by means of the time-of-flight method. The spectrometer provides the energy solution of several orders higher as compared with the known gravitational spectrometers. Under the conditions of pulsed fast reactors IBR-2 and IBR-30 operation using the proposed gravitational spectrometer with collimater slits of 0.3 mm height on the 1000 metre flight base the neu-

trons in the energy range E=0.1-10 eV can be monochromated with energy resolution 0.05 -.50%. The gravitational spectrometer experiment has been conducted at the IBR-30 operation in the reactor regime with average reactor thermal capacity of 15 kW assuring thermal neutron average flux on the moderator surface of approximately $3x10^{10}$ n/cm²xs, neutron pulses frequency being 4Hz, duration - 100 μs. The energy resolution obtained in the experiment is somewhat worse as compared with the calculation, it constitutes approximately 8%. The possibility of experimental neutron charge measurement at the 10^{-11}-10^{-14} level accuracy, 10^{-6} level gravity constant, 10^{-7} level spin dependence and 10^{-7} level neutron mass is substantiated.

30279 **(INS-TH—131) Current integrator using an ADC-module.** Gomi, K.; Imanishi, A.; Ukai, K. (Tokyo Univ., Tanashi (Japan). Inst. for Nuclear Study). 1 Dec 1980. 11p. (In Japanese). NTIS (US Sales Only), PC A02/MF A01. Order Number DE83701494.

A current integrator using an ADC (Analog to Digital Converter) module has been constructed to measure and intensity and a beam spill shape of a bremsstrahlung photon beam at the INS-ES. The main part of the integrator are an ADC, RAM (Random Access Memory) and a control logic. The ADC is the successive approximation type one with the resolution of 12 bits and the conversion speed of 20 μsec. The ADC output is transferred to the RAM with the 256 words of 12 bits. The data from the RAM is read into the computer by the CAMAC repeat mode. This report describes a design and a characteristics of the current integrator using the ADC-module.

30280 **(INS-TL—139) Focal plane detector for the INS-QDD magnetic spectrograph.** Tanaka, M.H.; Kubono, S.; Kato, S. (Tokyo Univ., Tanashi (Japan). Inst. for Nuclear Study). Jun 1981. 14p. NTIS (US Sales Only), PC A02/MF A01. Order Number DE83701500.

A focal plane detector of an effective length of 80 cm have been developed. The detector has a hybrid structure of a drift-space which has a large vertical acceptance, three thin position counters and two ΔE counters for particle identification of light ions. The position resolution obtained was 1.0 mm in FWHM for 32 MeV protons. The non-normal incidence effect was reduced down to about 0.5 mm by using three thin counters in tandem for position determination.

30281 **(JINR—1-81-686) Reference system of the relativistic ionization streamer chamber. Pt. 1. Description of the reference system.** Andreev, E.M.; Bahr, J.; Kulikov, V.V.; Schwind, A.E.; Bohm, G.; Halm, I.; Suvorov, V.M.; Hernes, I. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Problems). 1981. 6p. (In Russian). NTIS (US Sales Only), PC A02/MF A01. Order Number DE83700395.

The description of the reference system which performs a three-dimensional system of cartesian coordinates in the active volume (4600x1020x1000 mm³) of the spectrometer RISK is presented. By means of the reference system the coordinates of the streamer tracks in the chamber can be calculated. The reference system consists of the lower frame with 38 reference marks, the upper frame (illuminated grid of nylon threads), four fiducial marks in every of eight optical channels, eight fiducial cylinders mounted on the spectrometer magnet and eight stands for mounting geodesic measuring devices. In the figures the construction and elements of the reference system are shown.

30282 **(JINR—6-82-23) Three-level system for spectrometric data acquisition, processing and analysis.** Brudanin, V.B.; Vylov, Ts.; Gromov, K.Ya. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Problems). 1982. 15p. (In Russian). NTIS (US Sales Only), PC A02/MF A01. Order Number DE83700424.

A three-level system for acquisition, processing and analysis of nuclear spectrometric data is described. At the lower level there are units for data detection, conversion and accumulation. At the middle level there are units for collecting the spectrometric data and their preliminary processing. At the upper level there are units for final processing and analysis of the data. The suitable software is also considered.

30283 **(JINR—10-81-699) Organization of the processed event catalogue on the basis of direct access files.** Glagolev, V.V.; Govorun, N.N.; Ivanov, V.G.; Strizh, T.A. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Computing Techniques and Automation). 1981. 12p. (In Russian). NTIS (US Sales Only), PC A02/MF A01. Order Number DE83700420.

The system of programs that realizes a log-book on the basis of direct access files containing a history of processinthe chamber pictures is described. The organization of processing the film information in the framework of conventional INDEX system is considered. Its disadvantages which hamper the program application at the JINR are pointed out. The organization of the processing of film information from the JINR liquid hydrogen chambers using the catalogue of processed events (CPE) is described. The CPE structure and stored information are described in detail. The CPE in organized as a direct access file that provides a fast reading of information for one roll. The basic criteria used to indentify events in the process of their storage on the CPE are presented. The developed STATUS system is used in experiments performed on the VPK-100 and "LUDMILA" bubble chambers.

30284 **(JINR—10-81-700) Program package for creation and updating of the processed events catalogue.** Buzdavina, N.A; Ivanov, V.G.; Strizh, T.A. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Computing Techniques and Automation). 1981. 10p. (In Russian). NTIS (US Sales Only), PC A02/MF A01. Order Number DE83700421.

The package of programs for creating and updating a catalogue of processed events obtained from the JINR "Ludmila" and VPK-100 liquid hydrogen bubble chambers is described. The program system allows one to add to catalogue for every event processing step such information as scanning, measuring, data processing by kinematic identification programs, data summury tape creation. The package programs are used to obtain a list for every roll with either stoppoint or the second interaction or a kink etc., rotocol-passport cona pisting of every event frame number, x-coordinate of primary vertex, its label, topology, measuring device type and data summary tape type, and other lists and tables. The whole system is recorded as a PAM-file, the CCL language procedures being its main part. The procedures make it possible to simplify considerably the process of user's relations with a program package. The program package is embedded into the program generation system for film data processing at the JINR. The package inquiry language is described.

30285 **(JINR—10-81-754) Software for real time system of the DISK-2 spectrometer for investigation of cumulative particle production.** Ivanchenko, I.M.; Karpenko, N.N.; Panebrattsev, Yu.A.; Sadovnikov, V.N.; Senner, A.E.; Senner, L.A.; Stavinskij, V.S. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of High Energy). 1981. 11p. (In Russian). NTIS (US Sales Only), PC A02/MF A01. Order Number DE83700422.

Some problems of creating the software for real time system of the "DISK-2" spectrometer are considered. The spectrometer operates on-line with the ES-1040 computer. In the framework of the OS ES operational system the tasks of parallel performance of the process, effective use of computer resources are solved. Problems of organizing the "DISK" program system are considered; algorithms of experimental data acquisition are analyzed; data processing and subsystem of operative interaction of experimenter with the progrram complex are described. The created system provides effective solution of tasks of data acquisition, data processing and accumulation. The solftware considered allows one to carry out a cycle of studies of cumulative particle production.

30286 **(JINR—13-82-24) Design, technology of preparation and testing of polycarbonate track sensitive target.** Kiréev, V.I.; Sil'nichenko, A.F.; Tolmachev, V.T.; Khrenov, Yu.V. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of High Energy). 1982. 6p. (In Russian). NTIS (US Sales Only), PC A02/MF A01. Order Number DE83700396.

Design of internal track sensitive target intended for antideuteron-deuteron studies on the IHEP accelerator is described. Some ways of coupling, metallic connecting pipes with the target body and those of pasting together with the body itself, circuits and techniques of cyclic target testing after its preparation are given. The conclusion is drawn that it is possible to use this design for the operation together with "Ludmila" liquid hydrogen bubble chamber.

30287 **(JINR—R-13-81-735) Investigation of gas gain in a proportional chamber.** Kalinina, N.A.; Khazins, D.M. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Problems). 1981. 8p. (In Russian). NTIS (US Sales Only), PC A02/MF A01. Order Number DE83701531.

Gas gain measurements of a proportional chamber are compared with the analytical expressions. The measurements for the $(Ar:CH_4:COCH_3)_3CH_2:C_2H_5OH=55:36:6:3$ gas mixture at changing diameter of anode wire from 10 up to 400 μ, gas pressure in chamber P from 0.4 to 2.0 atm and various values of anode voltage U are performed. The data are in agreement with the formulae of Zastawny and Diethorn, which assumed a linear dependence of Ja/P from E/P.

30288 **(JINR-R—13-81-762) System of half-meter drift chambers operating in a self-quenching operation mode.** Alekseev, G.D.; Ganichev, V.I.; Gorchakov, O.E.; Kalinina, N.A.; Karpukhin, V.V.; Kruglov, V.V.; Kuptsov, A.V.; Luchan, L.; Khazins, D.M. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Problems). 1981. 11p. (In Russian). NTIS (US Sales Only), PC A02/MF A01. Order Number DE83700397.

The system of 18 drift chambers of 48x48 cm sensitive area including 864 information channels is described. Their characteristic properties are: a relatively small signal wire spacing (10 mm) and potential wire absence; self-quenching streamer(SQS) operation mode; parrallel encoding used for information readout. The chamber design and technology of manufacturing, readout electronics, counting and drift characteristics are presented. It is shown that SQS mode does not interfere with the drift chamber coordinate accuracy. The average accuracy (mean square deviation) for this system is about 0.2 mm.

30289 **(JINR-R—13-81-848) Setup for pion inverse electroproduction on protons and nuclei.** Alekseev, G.D.; Ganichev, V.I.; Gorchakov, O.E. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Problems). 1981. 10p. (In Russian). NTIS (US Sales Only), PC A02/MF A01. Order Number DE83700398.

Experimental setup for pion inverse electroproduction investigation on protons ($\pi^- + p \rightarrow e^+ + e^- + n$) and nuclei ($\pi + A \rightarrow e^+ + e^- + X$) is described. By this setup the above process on ^{7}Li nuclei has been detected. Electrons and positrons of the reaction are detected with three telescopes, each containing drift chambers, scntillation counters, water Cherenkov counters and Cherenkov lead glass spectrometers. Sensitive area of each detector is 500x500 mm^2.

30290 **(JINR-R—13-82-42) Characteristics of half-meter drift chambers operating in self-quenching streamer mode.** Alekseev, G.D.; Kalinina, N.A.; Khazins, D.M. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Problems). 1982. 11p. (In Russian). NTIS (US Sales Only), PC A02/MF A01. Order Number DE83700399.

The methods to obtain geometrical corrections, drift characte-- ristics and coordinate accuracy for the half-meter drift chamber system are described. The distance between anode wires in these chambers is 10 mm, potential wires which are usually used in drift chamber are absent. The chambers operate in self-quenching streamer mode. Their characteristics are measured at 80 MeV pion beam. The mean square deviation in measuring track coordinates averaged over the total chamber system is 0.2 mm.

30291 **(LA-UR—83-796) Stereo: cylindrical drift chamber for muon decay experiments at LAMPF.** Bolton, R.D.; Carlini, R.D.; Cooper, M.D.; Frank, J.S.; Hart, V.E.; Matis, H.S.; Mischke, R.E.; Sandberg, V.D.; Sennhauser, U. (Los Alamos National Lab., NM (USA)). 1983. Contract W-7405-ENG-36. 22p. (CONF-830223—3). NTIS, PC A02/MF A01. Order Number DE83010086.

From Wire chamber conference; Vienna, Austria (15 Feb 1983).

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A stereo, cylindrical drift chamber has been built for use in a search for rare decay modes of the muon at LAMPF. This chamber (part of the Crystal Box detector) has 728 cells on 8 concentric annuli at alternating angles of 10° to 16° from the chamber axis and with radii from 105 to 220 mm. The basic cell cross section is (9 x 10) mm^2 and the inter-layer spacing is 4.7 mm. Preliminary results show the single-wire efficiencies to be greater than 99%. Based on results obtained from prototype chambers, we hope to achieve 170-μm resolution (including multiple scattering) when TDC offsets and sense-wire locations found in a careful inspection of the end-plates are added to the track-finding algorithm.

30292 **(OEFZS—4079) Coincidence-type ion-electron converter detector for low-energy protons.** Benka, O.; Weinzierl, P.; Dobrozemsky, R.; Stratowa, C. (Oesterreichisches Forschungszentrum Seibersdorf G.m.b.H. Inst. fuer Physik). Apr 1981. 40p. (PH—320/81). NTIS (US Sales Only), PC A03/MF A01. Order Number DE83701524.

A coincidence type ion-electron converter detector has been developed and used - together with an electrostatic energy-analyser - for precision measurements of the energy distribution of recoil protons from free-neutron decay. The most important aspect of the development was, besides keeping the background below 0,2 counts/sec in the presence of a certain radiation background, to achieve a high and energy-independent counting probability for protons with energies between 100 and 1000 eV. With an acceleration voltage of about 25 kV and Al-foils (20 to 35 ug/cmsup2) as converter, we obtained counting efficiences of 70 to 85 percent. The design and performance of the detector system, employing six foils with different sensitive areas, are described and discussed in detail.

30293 **(ORNL/TM—8355) Neutron and gamma-ray shielding requirements for a below-ground neutrino detector system at the Rutherford Laboratory Spallation Neutron Source.** Gabriel, T.A.; Lillie, R.A.; Childs, R.L.; Wilczynski, J.; Zeitnitz, B. (Oak Ridge National Lab., TN (USA)). Mar 1983. Contract W-7405-ENG-26. 26p. NTIS, PC A03/MF A01. Order Number DE83010407.

The neutron and gamma-ray shielding requirements for a proposed neutrino system below the target station at the Rutherford Laboratory Spallation Neutron Source (SNS) are studied. The present shield below the station consists of 2 meters of iron and 1 meter of concrete, below which is chalk ($CaCO_3$). An underground bunker housing the neutrino detector system would require additional shielding consisting of 6 meters of the chalk plus ~ 3 meters of iron to reduce the number of high-energy (> ~ 7 MeV) neutrons and gamma rays entering the detector system to an acceptable level of ~ 1 per day.

30294 **(PNL-SA—10888) Field practices and techniques: introduction.** Roesch, W.C. (Pacific Northwest Lab., Richland, WA (USA)). Mar 1983. Contract AC06-76RL01830. 10p. (CONF-830204—10). NTIS, PC A02/MF A01. Order Number DE83010166.

From International beta dosimetry symposium; Washington, DC, USA (15 Feb 1983).

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Field measurements of beta particles for radiation protection are made at the surface of a (simulated) body; in contrast, gamma-ray measurements are made free-in-air. The standard instrument for beta measurements is the extrapolation chamber. Practical instruments may fail to match the extrapolation chamber's dependence on source direction or energy. Beta measurements often have to be made so close to the source that some way of correcting for instrument size is needed. This talk is intended to lay the groundwork for

the session on field practices and techniques in beta-particle dosimetry. I will describe some of the major dosimetry problems and give general information about them, but specific solutions to the problems will appear in the papers during the sessions.

30295 **(RL—81-088) Review of currently available high performance interactive graphics systems.** Clark, S.A.; Harvey, J. (Science Research Council, Chilton (UK). Rutherford and Appleton Labs.). Dec 1981. 10p. NTIS (US Sales Only), PC A02/MF A01. Order Number DE83701544.

A survey of several interactive graphics systems is given, all but one of which being based on calligraphic technology, which are being considered for a new High Energy Physics graphics facility at RAL. A brief outline of the system architectures is given, the detailed features being summarised in an appendix, and their relative merits are discussed.

30296 **(CAPE—2815) SLAC - CAMAC hardware standard (Engineering Materials).** (Stanford Linear Accelerator Center, CA (USA)). 1 Mar 1983. Contract AC03-76SF00515. USDOE-TIC, PO Bx 62, Oak Ridge, TN 37830.

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The drawing list DL-135-772-00-RO and the drawings listed thereon provide the construction information and specifications for CAMAC Module Hardware currently in use at the Stanford Linear Accelerator Center are based on, and conform to, the international standards for Computer Automated Measurement and Control (CAMAC) systems, as further defined in the ANSI/IEEE Standard 583-1982, Modular Instrumentation and Digital Interface System (CAMAC)'. The drawings of this package define the actual parts fabrication details, in such a way that module assembly may be accomplished to the specification tolerances, without the need for alignment and/or test fixtures.

30297 **Precise real-time wavemeter.** Carter, H.K. (UNISOR, Oak Ridge, TN (USA)); Bingham, C.R.; Pegg, D.J.; Gaillard, M.L. (Tennessee Univ., Knoxville (USA); Oak Ridge National Lab., TN (USA)); Zganjar, E.F. (Louisiana State Univ., Baton Rouge (USA)); Griffin, P.M. (Oak Ridge National Lab., TN (USA)). *Nuclear Instruments and Methods in Physics Research;* **202**: No. 1/2, 361-364(1 Nov 1982).

From 6. international conference on fast ion beam spectroscopy; Quebec (Canada) (17 - 20 Aug 1981).

A wavemeter has been built utilizing a coincidence start/stop fringe counting technique with a standard, simple division-of-amplitude type interferometer. We utilize a microprocessor to control the counting and to calculate and display, in real time, the unknown wavelength and to indicate when the result is outside of a present tolerance (e.g. mode hop). This system, utilizing the coincidence technique, gives an enhancement in the precision of at least a factor of 15 over standard fringe counting techniques.

30298 **Calorimetry design for high-energy particle detection.** Gabriel, T.A.; Bishop, B.L.; Lillie, R.A. (Oak Ridge National Laboratory, Oak Ridge, TN 37830). *Transactions of the American Nuclear Society;* **41**: 478-480(Jun 1982). (CONF-820609—).

From American Nuclear Society annual meeting; Los Angeles, CA, USA (6 Jun 1982).

30299 **Portable instrument for inspecting irradiated nuclear-fuel assemblies in a water-filled storage pond by measurement of induced Cerenkov radiation.** Nicholson, N.; Dowdy, E.J.; Holt, D.M.; Stump, C.J. Jr. US Patent Application 6-377,773. 13 May 1982. 17p. Contract W-7405-ENG-36.

A portable instrument for measuring induced Cerenkov radiation associated with irradiated nuclear fuel assemblies in a water-filled storage pond is disclosed. The instrument includes a photomultiplier tube and an image intensifier which are operable in parallel and simultaneouly by means of a field lens assembly and an associated beam splitter. The image intensifier permits an operator to aim and focus the apparatus on a submerged fuel assembly. Once the instrument is aimed and focused, an illumination reading can be obtained with the photomultiplier tube. The instrument includes a lens cap with a carbon-14/phosphor light source for calibrating the apparatus in the field.

30300 **Radiation dosimeter.** Fox, R.J. US Patent Application 6-298,448. 1 Sep 1981. 11p. Contract W-7405-ENG-26.

A radiation detector readout circuit is provided which produces a radiation dose-rate readout from a detector even through the detector output may be highly energy dependent. A linear charge amplifier including an output charge pump circuit amplifies the charge signal pulses from the detector and pumps the charge into a charge storage capacitor. The discharge rate of the capacitor through a resistor is controlled to provide a time-dependent voltage which when integrated provides an output proportional to the dose-rate of radiation detected by the detector. This output may be converted to digital form for readout on a digital display.

4402 Radiation Effects On Instrument Components, Instruments, Or Electronic Systems

30301 **(SAND—83-0823C) Three micron CMOS technology for custom high reliability and radiation-hardened integrated circuits.** Nordstrom, T.V.; Light, R.W.; Sexton, F.W. (Sandia National Labs., Albuquerque, NM (USA)). 1983. Contract AC04-76DP00789. 15p. (CONF-830537—1). NTIS, PC A02/MF A01. Order Number DE83010825.

From Custom integrated circuits conference; Rochester, NY, USA (23 May 1983).

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A new radiation hardened three micron CMOS process has been developed. It uses a guardbanded P-well with single level polysilicon and single level metal. Plasma processing is used for etching the critical dimension levels of polysilicon, contact window and metal. To date, fifteen designs have been fabricated using the technology. These include CMOS equivalents of the Intel 8085 8-bit microprocessor family, two custom encryption chips of about 19,000 transistors each and custom logic designs using Sandia's standard cell family. Performance of the devices has exceeded all specifications.

30302 **(UCID—19770) Identification of antenna parameters from time-domain pulse-response data.** Clark, G.A.; Martin, L.C.; Bogdan, E.J. (Lawrence Livermore National Lab., CA (USA)). Apr 1983. Contract W-7405-ENG-48. 183p. NTIS, PC A09/MF A01. Order Number DE83008896.

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The Department of the Navy is concerned with the effects of large EMPs on shipboard electronics packages, particularly those attached to antennas (radios, transmitters, etc.). The goal is to eventually use our understanding of these effects to design EMP-hardened electronics packages. EMP hardening techniques include using gas diodes in parallel with critical components to limit the voltages across them. This report analyzes the important and difficult problem of identifying antenna parameters from transient electromagnetic data. The identification problem is defined and shown to be difficult for the transient case. Several identification schemes are discussed and examples of results are given. The most promising technique for transient identification appears to be one using a linear pole-zero model that is estimated iteratively using the entire data-record pair at each iteraction. We call this an iteractive batch technique, and an example identification is presented for a 30-cm monopole antenna because its properties are known theoretically. It is shown that the calculated impedance and effective-height values agree with theory. Emphasis is placed on the fact that before identification can be carried out, extreme care must be exercised to ensure that the measurement data are sampled properly, and that proper preprocessing is done. Problems for future work are discussed, along with recommendations, and the identification results are summarized. (WHK)

30303 Radiation-hard electrical coil and method for its fabrication. Grieggs, R.J.; Blake, R.D.; Gac, F.D. US Patent Application 6-393,287. 29 Jun 1982. 13p. Contract W-7405-ENG-36.

A radiation-hard insulated electrical coil and method for making the same are disclosed. In accordance with the method, a conductor, preferably copper, is wrapped with an aluminum strip and then tightly wound into a coil. The aluminum-wrapped coil is then annealed to relax the conductor in the coiled configuration. The annealed coil is then immersed in an alkaline solution to dissolve the aluminum strip, leaving the bare conductor in a coiled configuration with all of the windings closely packed yet uniformly spaced from one another. The coil is then insulated with a refractory insulating material. In the preferred embodiment, the coil is insulated by coating it with a vitreous enamel and subsequently potting the enamelled coil in a castable ceramic concrete. The resulting coil is substantially insensitive to radiation and may be operated continuously in high radiation environments for long periods of time.

4403 Miscellaneous Instruments

REFER ALSO TO CITATION(S) 28835, 29391, 29812, 29921, 30075, 30103, 30128, 30149, 30402, 30418, 30419, 30425

30304 (CEA-CONF—6089) Time-of-flight method for positron tomographic imaging and state-of-the-art of detector technology for emission tomography. Allemand, R.; Campagnolo, R.; Garderet, P.; Gariod, R.; Laval, M.; Moszynski, M.; Tournier, E.; Vacher, J. (CEA Centre d'Etudes Nucleaires de Grenoble, 38 (France)). Oct 1981. 23p. (CONF-8110168—2). NTIS (US Sales Only), PC A02/MF A01. Order Number DE83700392.

From NATO advanced study institute on diagnostic imaging in medicine; Castelvecchio, Italy (11 Oct 1981).

Positron imaging is essentially a method for studying dynamic phenomena and positron emitters are characterized by a short life which allows to inject a high activity. This means that a high counting-rate capability is a major feature of a P.C.T.; furthermore a high resolving time permits to reduce the random coincidence events which yield a low spatial frequency back-ground reducing the contrast of the image and introducing an error for quantitative measurements. For these points of view, CsF appears to be the most suitable scintillator. Its fast light emission allows to reach a time-of-flight information which improves the signal to noise ratio of the image. That advantage is a function of the object size and of the T.O.F. accuracy. Now, a 500 psec time resolution (FWHM) seems to be a realistic characteristics for an operational machine. The comparison between the conventional method and the T.O.F. technique has been expressed in terms of sensitivity gain which is the ratio of the number of events needed to obtain the same signal to noise ratio. A sensitivity gain of 4 has been theoretically estimated with a 500 psec timing and for a 450 mm diameter phantom. This evaluation seems to be in a good agreement with the first experimental results.

30305 (EGG—10282-5001) Testing of gated microchannelplate (MCP) intensifiers at EG and G/LAO. Stump, C.; Justice, R. (EG and G, Inc., Los Alamos, NM (USA). Energy Measurements Group). Feb 1983. 20p. NTIS, PC A02/MF A01. Order Number DE83010524.

This report summarizes the repertoire of tests and test results developed in support of the P-15 gated intensifier program. We believe that we now have demonstrated the capability at LAO to perform routine microchannel plate characterization of both static and dynamic performance. The following are the tests and measurements we performed on five new MCPs (S/Ns ITT-14-928/2, 3, 4H, 6, and 7H): (1) photocathode sensitivity vs wavelength, (2) optical gain vs MCP voltage, (3) optical gain vs photocathode voltage, (4) central transmission vs shutter time, (5) photographs of resolutions vs back bias voltage, and (6) time response measurements with pulsed laser images. These tests and measurements are discussed in detail. (WHK)

30306 (INR—1912) Interface unit for the Y-time mode registrator. Andrzejak, R. (Institute of Nuclear Research, Warsaw (Poland)). 1981. 18p. (In Polish). Energetics and Atomic Energy Information Centre, Warsaw, Poland.

The construction and operation of a CAMAC interface for the Y-time mode registrator is described.

30307 (JINR—13-81-713) 8-input doublet analogue multiplexer. Kuznetsov, A.N. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Reactions). 1981. 4p. (In Russian). NTIS (US Sales Only), PC A02/MF A01. Order Number DE83700400.

The multiplexer involving two similar analogue swithboards has been developed. Two identical switchboard channel gates start by the signal at a suitable control input. The multiplexer notes the number of the switched channels, it has significant CAMAC logical capability and provides the interaction with two ADC. That allows one to reduce the total number of the techniques used in the multichannel system measuring the whole energy E and the relative energy dissipation ΔE in the system involving general pairs of the ΔE, E detectors. The functional circuit, the main technical characteristics and basic parts of the multiplexer electrical circuit are presented. An analogue switchboard has an input resistance of 1.3 kOhm, a transfer factor - 1, output resistance - 50 Ohm, temperature instability of output voltage not more than 50 μV/deg C. The amplitude of the switchboard input pulses can vary from 0 to +10 V. Rate of increase in the output voltage is near 100 V/μs. Minimum signal duration of outer control amounts to 30 ns.

30308 (JINR—R-13-81-365) Systematic errors in polarization measurements of polarized proton targets by the Q-meter method. Liburg, M.Yu.; Matafonov, V.N. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Problems). 1981. 11p. (In Russian). NTIS (US Sales Only), PC A02/MF A01. Order Number DE83701515.

Correlation for apparatus nonlinearity of two types of Q-meters mostly applicabl for measuring the proton target polarization for Gaussian and lorentzian absorption spectrum line shapes of NMR are calculated. Q-mete device registering variations of the inpedance module of a tuned radicuit, the induction coi of which contns the target. The Q-meter operation with phase automatic control is analysed. It is shown that the residual error for phase utomatic control factors S6 is less than 0.2%. The calculation results are presented in graphs and could be used for correction of the Q-meter proton target polarization at limited information of iput circuit parameters.

30309 (LA-UR—83-918) Development of high-speed microchannel photomultiplier. Simmons, D.F.; Smith, B.A.; Davis, B.A.; Lyons, P.B. (Los Alamos National Lab., NM (USA)). 1983. Contract W-7405-ENG-36. 9p. (CONF-830425—2). NTIS, PC A02/MF A01. Order Number DE83009896.

From Society of Photo-Optical Instrumentation Engineers conference; Santa Fe, NM, USA (11 Apr 1983).

Progress in the development of a high-speed microchannel plate (MCP) photomultiplier is reviewed. The device consists of a semitransparent photocathode and MCP with a tapered 50 ohm anode. Two prototypes have been built and evaluated. One has an accelerating screen between the MCP and anode. The other has no screen, but is otherwise identical. Time response data is presented for the two prototypes showing the effect of the screen.

30310 Mobile mass spectrometry laboratory for isotopic ratio measurements of uranium and plutonium. Smith, D.H.; Walton, J.R.; McKown, H.S.; Walker, R.L.; Carter, J.A. (Oak Ridge National Lab., TN (USA)). *Analytica Chimica Acta;* **142**: 355-359(1 Oct 1982).

A modified quadrupole mass spectrometer is housed in a van that serves as a mobile laboratory to provide on-site determinations of isotopic ratios and concentrations of uranium and plutonium. Each element can be determined at 1-3 ng levels with precisions of 1-2%.

30311 Apparatus and method for measurement of weak optical absorptions by thermally induced laser pulsing. Cremers, D.A.; Keller, R.A. US Patent Application 6-386,372. 8 Jun 1982. 28p. Contract W-7405-ENG-36.

The thermal lensing phenomenon is used as the basis for measurement of weak optical absorptions when a cell containing the sample to be investigated is inserted into a normally continuous-wave operation laser-pumped dye laser cavity for which the output coupler is deliberately tilted relative to intracavity circulating laser light, and pulsed laser output ensues, the pulsewidth of which can be rlated to the sample absorptivity by a simple algorithm or calibration curve. A minimum detection limit of less than 10^{-5} cm^{-1} has been demonstrated using this technique.

30312 Apparatus and method for quantitative measurement of small differences in optical absorptivity between two samples using differential interferometry and the thermooptic effect. Cremers, D.A.; Keller, R.A. US Patent Application 6-386,371. 8 Jun 1982. 28p. Contract W-7405-ENG-36.

An apparatus and method for the measurement of small differences in optical absorptivity of weakly absorbing solutions using differential interferometry and the thermooptic effect has been developed. Two sample cells are placed in each arm of an interferometer and are traversed by colinear probe and heating laser beams. The interrogation probe beams are recombined forming a fringe pattern, the intensity of which can be related to changes in optical pathlength of these laser beams through the cells. This in turn can be related to small differences in optical absorptivity which results in different amounts of sample heating when the heating laser beams are turned on, by the fact that the index of refraction of a liquid is temperature dependent. A critical feature of this invention is the stabilization of the optical path of the probe beams against drift. Background (solvent) absorption can then be suppressed by a factor of approximately 400. Solute absorptivities of about 10^{-5} cm^{-1} can then be determined in the presence of background absorptions in excess of 10^{-3} cm^{-1}. In addition, the smallest absorption measured with the instant apparatus and method is about 5 x 10^{-6} cm^{-1}.

30313 Coal gasification and fluidized bed combustion. Romanosky, R.R. (Morgantown Energy Tech. Center, WV). *Journal of Coal Quality;* **2**: No. 1, 9-10(Win 1982).

A large research effort at the Morgantown Energy Technology Center to develop instrumentation for process steam characterization in support of both gasification and fluidized bed combustion technology development is discussed. For measurement of particles in the process stream, a non-intrusive laser-based optical particle monitor was developed and is being field tested. This instrument, based on the use of laser beam interference patterns and light scattering, can operate in either of two particle size ranges. Using the light scatteirng mode, particles in the 0.3 to 3 micron range can be quantized or, using interference patterns, sizes of 3 to 30 microns can be determined. A unique mass spectrometer was also developed for the analysis of particles in a gas stream. The laser device allows real time continuous monitoring of the gas composition from fluidized bed combustion of coal. The spectrometer system is able to determine concentrations of nitrogen, carbon monoxide, and hydrogen sulfide. (JMT)

30314 Developments in high-speed pyroelectric detectors. Stotlar, S.C.; McLellan, E.J. (Los Alamos National Lab., NM). *Optical Engineering;* **20**: No. 3, 469-471(May-Jun 1981).

Pyroelectric detectors have been developed at Los Alamos National Laboratory (LANL) for use with high-frequency applications such as laser fusion. Less than 50-ps total response time devices have been measured. The voltage responsivity with a 50-Ω load is about 5 to 10 V/MW, requiring 10 to 20 mJ/cm^2 to produce 1-V, 1-ns pulses. The latter are 1 mm^2 in area. High-speed devices with up to 1 cm^2 area have been developed. A novel method of fabrication now permits voltage responsivities up to 50 V/MW with a 50-Ω load. This improved sensitivity detector is slower than the fastest design but is still suitable for measuring 1-ns pulses.

30315 Space and time resolved soft x-ray spectra using x-ray transmission gratings. Ceglio, N.M.; Hawryluk, A.M.; Price, R.H. (Lawrence Livermore National Lab., CA). *Proceedings of the Society of Photo-Optical Instrumentation Engineers;* **316**: 134-142(1981). Contract W-7405-ENG-48.

From Conference on high resolution soft x-ray optics; Upton, NY, USA (18 Nov 1981).

Gold transmission gratings with 0.3 μm spatial period, 0.6 μm thick have been fabricated, and are being used for the spectroscopy of high temperature, laser produced plasmas. A transmission grating has been coupled with a soft x-ray streak camera, producing the first time resolved (20 psec resolution) continous x-ray spectrum over the range 0.1 to 1.5 keV from a laser produced plasma. In addition, a transmission grating has been coupled with a high resolution, Woelter-design x-ray microscope to produce an imaging spectrometer of unprecedented spatial and spectral resolution. In laboratory experiments the imaging spectrometer demonstrated a spectral resolving power, ($\lambda/\Delta\lambda$) of 200 and a spatial resolution of 1 μm.

30316 Free disk as an absolute viscometer and the viscosity of water in the range 25 to 150°C. Kestin, J.; Shankland, J.R. (Brown Univ., Providence, RI). *Journal of Non-Equilibrium Thermodynamics;* **6**: 241-256(1981). Contract AC02-81ER10811.

The paper develops the equations which make it possible to measure the viscosity of a liquid, on an absolute basis, by the use of a free-oscillating disk. The advantage of this development, compared with the usual method in which the disk is made to oscillate between two fixed plates, is the fact that it is no longer necessary to compensate for differential thermal expansion. This greatly simplifies the design for high-temperature operation. In practice, the flat faces of the confining vessel are at an infinite distance from the oscillating disk. The method is validated in relation to new absolute measurements of the viscosity of liquid water in the temperature range from 25 to 150°C. The results agree remarkably well (to +- 0.2%) with a critical correlation obtained earlier in this laboratory. The mutual consistency of these two sets of values inspires confidence in the method of measurement as well as the correlation.

4404 Well Logging Instrumentation

30317 (NUREG/CR—3186) Review of well-logging techniques. Olsen, K.B.; Young, J.A.; Thomas, V.W. (Pacific Northwest Lab., Richland, WA (USA)). Apr 1983. Contract AC06-76RL01830. 29p. (PNL—4634). NTIS, PC A03/MF A01 - GPO $3.75. Order Number DE83010786.

A literature review has been conducted to determine whether suitable borehole-logging techniques exist for the measurement of gamma-ray-emitting elements using downhole detectors. Most of the methods that have been used for the last 30 years by the uranium-exploration industry involve passive gamma-ray measurement techniques utilizing NaI(Tl) and, occasionally, intrinsic germanium detectors. Parameters the industry has had to consider in calibrating these detectors are variations in (1) casing material and thickness, (2) water in the borehole, (3) hole diameter, (4) disequilibrium between uranium and its daughters in the ore zone, (5) spatial distribution of the radioactive material, and (6) dead time of the analyzer. The methods they have used to address these variable parameters appear to be applicable to remedial action programs. The techniques that have been used for the measurement of subsurface radium concentration by DOE during the engineering assessment of UMTRAP/FUSRAP sites and by NRC at one remedial action site will be described in this report.

45 EXPLOSIONS AND EXPLOSIVES

4501 Chemical

REFER ALSO TO CITATION(S) 30028

30318 **(SAND—83-0770C) Recent studies of airblast from buried charges, for environmental charges, for environmental protection from HEST events.** Reed, J.W. (Sandia National Labs., Albuquerque, NM (USA)). 1983. Contract AC04-76DP00789. 11p. (CONF-830624—1). NTIS, PC A02/MF A01. Order Number DE83008904.

From 8. international symposium on military applications of blast simulation; Spiez, Switzerland (20 Jun 1983).

Characteristics of blast waves from explosions in simple geometries and containment media have been well defined by hydrodynamic models and verified by experiment. A large class of useful explosions, those only partially contained by the close surrounding medium, are less-adequately understood. This report addresses the problem of airblast emitted into the atmosphere from explosions buried in the ground at less than containment depth. Examples of such explosions have arisen in cratering excavation, mining and quarrying, ordnance disposal, and military High Explosives Simulation Tests (HEST). Some recent HEST data have been assembled here to help define an empirical approach to airblast predictions, for operational safety as well as for controlling environmental impact on neighboring communities.

30319 **(UCRL—52000-83-2) Energy and Technology Review.** (Lawrence Livermore National Lab., CA (USA)). Feb 1983. Contract W-7405-ENG-48. 35p. NTIS, PC A03/MF A01. Order Number DE83010360.

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Individual articles from this description of research activities at Lawrence Livermore Laboratories were prepared separately for the data base. (GTH)

30320 (UCRL—52000-83-2, pp 1-10) **Shock initiation of high explosives.** Feb 1983. NTIS, PC A03/MF A01.

In Energy and Technology Review.

We have substantially advanced the experimental and theoretical study of shock initiation in the past five years. The current generation of our stress and particle-velocity gauges allows quantitative input to a predictive initiation model. Fast infrared radiometry has provided insight into the ignition and growth aspect of initiation and provided semiquantitative data on particle-size effects for inclusion into the model. This approach, combining experimental and theoretical studies, has already paid off in the design and modeling of our initation systems, which are important to a weapon's safety and vulnerability as well as to its performance.

30321 **Description of a shock-wave velocity barrier.** Walker, F.E. (Lawrence Livermore Lab., CA). *Propellants and Explosives;* **6**: 15-16(1981). Contract W-7405-ENG-48.

An analogy can be drawn between the sonic barrier in transonic flight, the thermal barrier in supersonic or hypersonic flight, and the limiting of the detonation process in high explosives.

4503 Explosion Detection

30322 **(UCID—19780) E-field-ratio telluric techniques applied to cavity detection for OSI operations.** Didwall, E.M.; Wilt, M.J. (Lawrence Livermore National Lab., CA (USA)). Apr 1983. Contract W-7405-ENG-48. 30p. NTIS, PC A03/MF A01. Order Number DE83010983.

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Verification of compliance to a Comprehensive Test Ban Treaty (CTBT) may require an On-Site Inspection (OSI) of an area in the USSR where an underground nuclear test may have been conducted. As one of the possible technologies that may be applied by an OSI team, the E-field-ratio telluric method for cavity detection is examined. This method utilizes naturally occurring earth currents which are induced by ionospheric and tropospheric electromagnetic activity - no electric field source is provided by the user, thus reducing equipment requirements. Two test surveys were made at the Nevada Test Site. Underground cavities at these locations are expected to have lateral extents of the order of a few 10's of meters and depths less than 300 meters. Telluric measurements indicate that an electrically resistive anomaly exists where the cavity is expected. The anomaly associated with the cavity could be detected even when the survey line did not cross directly over the expected cavity location. Although these experiments do not define the limitations of the method, they do show strong evidence that cavities and chimney formations from an underground nuclear explosion can be detected. Specific goals for further research are suggested.

50 ENVIRONMENTAL SCIENCES, ATMOSPHERIC

5001 Basic Studies

REFER ALSO TO CITATION(S) 29750, 30330, 30531

30323 **(BNL—32370) Variation of turbulence within the TIBL.** SethuRaman, S.; Brinkman, D. (Brookhaven National Lab., Upton, NY (USA)). 1983. Contract AC02-76CH00016. 4p. (CONF-830307—10). NTIS, PC A02/MF A01. Order Number DE83005807.

From 6. American Meteorological Society symposium on turbulence and diffusion; Boston, MA, USA (22 Mar 1983).

Variations of longitudinal, lateral and vertical turbulence in the coastal region due to a change in surface roughness and the diurnal cycle were investigated. A brief summary is given. The analysis was performed on the following variables - mean wind speed and longitudinal, lateral, and vertical turbulence. Standard deviations of the fluctuating quantities were used as indicators of turbulence. These two parameters significantly affect the transport and diffusion of pollutants released in the atmosphere. The analysis also included a comparison of these parameters at the coastal site, Tiana Beech with the inland station Hampton Bays 5km away. The hourly mean and turbulence observations pertain to a period of about 40 days in the fall of 1980. These were continuous observations through day and night at both the stations. Detailed results will be published. (PSB)

30324 **(NUREG/CR—3211) Dust climatology of the western United States.** Changery, M.J. (National Climatic Center, Asheville, NC (USA)). Apr 1983. 44p. NTIS, PC A03/MF A01 - GPO $4.75. Order Number DE83901961.

Beginning and ending times of dust-caused visibility values were extracted from original records for approximately 180 stations in the western US for the general period of record 1948 to 1977. Maps are presented depicting the annual total number of hours with visibility below specified values, annual number of dust episodes, dust episode durations, season of occurrence, and probability of thunderstorm-inducement.

30325 **Numerical model study of turbulent airflow in and above a forest canopy.** Yamada, T. (Los Alamos National Lab., NM). *Journal of the Meteorological Society of Japan;* **60**: No. 1, 439-454(28 Feb 1982).

A simplified second-moment turbulence closure model, which has been reasonably well tested in various geophysical problems, is used to simulate effects of a tall tree canopy on air circulations in the atmospheric boundary layer. Qualitative simulation of a canopy flow, with nearly constant and low wind speeds in a canopy, but large wind shears near a treetop, and unstable (stable) temperature layers within a canopy during the night (day) are all satisfactory. Strong couplings between the mean and turbulence variables are obvious when simulations performed with and without a canopy in the model are compared with one another.

30326 **Kolmogoroff constants at the 1976 ITCE.** Dyer, A.J. (CSIRO, Victoria, Australia); Hicks, B.B. *Boundary-Layer Meteorology;* **22**: 137-150(1982).

The high-frequency data from 12 sensors at the ITCE 1976 are analyzed to determine the Kolmogoroff constants for velocity, temperature and humidity fluctuations, α/sub u/, α/sub T/, and α/sub q/. The occurrence of aliasing in the spectral analysis in some cases together with the limited response of some sensors at the higher frequencies introduces some uncertainties into the analysis.

The Soviet sonic anemometer, fine-wire thermometer and infrared hygrometer and the Australian infrared hygrometer provide the best information, namely that: α/sub u/ = 0.59 +/- 0.01, α/sub T/ = 0.68 +/- 0.02, α/sub q/ = 0.76 +/- 0.03, where the errors quoted refer solely to statistical errors. The other instruments provide general support to these values. The technique of using spectral density measurements to determine eddy fluxes is illustrated.

30327 **Temperature-dependent ultraviolet absorption spectrum for dinitrogen pentoxide.** Yao, F. (California Univ., Berkeley); Wilson, I.; Johnston, H. *Journal of Physical Chemistry;* 86: No. 18, 3611-3615(1982). Contract AC03-76SF00098.

The ultraviolet absorption cross sections for N_2O_5 are presented for wavelengths between 200 and 380 nm and for temperatures between 223 and 300 K. The absorption spectrum above 290 nm shows a pronounced temperature dependence.

30328 **Size effects in aerosol particle interactions: the Van der Waals potential and collision rates.** Marlow, W.H. (Brookhaven National Lab., Upton, NY). *Surface Science;* 106: 529-537(1981). Contract AC02-76CH00016.

Three effects which are explicitly dependent on aerosol particle size are identified and discussed. They are focussed about the particle collision rate and how it relates to the properties of the gas, the particle, and the particle's interaction potential energy which play roles in particle-particle collision rates. By incorporating the conduction electronic free path effect for conductors into the frequency-dependent dielectric constants of silver and graphite, particle size effects in the Lifshitz-Van der Waals potentials for identical pairs of 1 nm and 100 nm particles are evaluated. Water and tetradecane particle interaction potentials for the same size particles are also calculated to illustrate size effects due to the retardation of the interaction. These potentials are then used to calculate the enhancement of the particle collision rates above their value in the absence of any potential at various gas pressures. The roles of the interaction potential in collision among identical pairs of particles of differing compositions is also briefly discussed.

5002 Chemicals Monitoring And Transport

REFER ALSO TO CITATION(S) 28864, 28874, 30387

30329 **(AD-A—123072/1) Satellite measurements of atmospheric aerosols. Annual report 1 Oct 81-30 Nov 82.** Griggs, M. (Science Applications, Inc., La Jolla, CA (USA)). 22 Dec 1982. 20p. NTIS, PC A02/MF A01.

Analysis of NOAA-6 AVHRR data and ground truth measurements at Midway show excellent agreement between the satellite inferred values of aerosol optical thickness and the ground truth values. Similar agreement was found previously at San Diego and on the USNS Hayes in the Atlantic Ocean, suggesting that the satellite technique for measuring tropospheric aerosols has global application.

30330 **(BNL—51625) Study of air-pollution mixing heights and atmospheric turbulence over New York City - data report.** SethuRaman, S.; Henderson, C.; Volk, T.; Hoffert, M.I. (Brookhaven National Lab., Upton, NY (USA)). Aug 1982. Contract AC02-76CH00016. 33p. NTIS, PC A03/MF A01. Order Number DE83010624.

A major factor that affects the variation of ground-level concentration of air pollutants such as particulates, sulfur oxide, nitrogen oxides, carbon monoxide, hydrocarbons, and photochemical oxidants is the mixing height in the earth's atmosphere close to the surface. This is the layer within which processes associated with the atmospheric turbulence generated by the surface roughness and heating dominate. In order to investigate the variation of this mixing height and associated turbulence over New York City, an experiment was performed over the Barney building of New York University located in lower Manhattan. The mixing height was measured continuously with an acoustic sounder for 10 days from the roof of the Barney building estimated to be 50m above the street level. Several meteorological instruments were used on a 16m tower located on the roof of this building to study other atmospheric variables in the mixed layer. A description is given of the instruments and the data acquisition system used in the experiment. The data reveal significant heights of the mixed layer (200 to 400m) during nocturnal conditions which are probably due to urban heat island effects. Horizontal turbulence levels vary between 10 and 20 percent.

30331 **(CONF-830338—2) Surface-emission monitoring for formaldehyde source-strength analysis.** Matthews, T.G. (Oak Ridge National Lab., TN (USA)). 1983. Contract W-7405-ENG-26. 12p. NTIS, PC A02/MF A01. Order Number DE83009787.

From APCA specialty meeting on measurement and monitering of non-criteria toxic contaminants; Chicago, IL, USA (22 Mar 1983).

A passive surface-emission monitor has been developed for non-destructive measurement of formaldehyde (CH_2O) emission rates from CH_2O resin-containing materials such as urea-formaldehyde foam insulation (UFFI) and pressed-wood products. The monitor seals with the flat surface of a solid CH_2O emission source. The emitted CH_2O is sorbed by a planar distribution of solid sorbent (13X molecular sieve), supported at a fixed distance from the test medium. The CH_2O uptake of the exposed molecular sieve can be determined using a water-rinse desorption and colorimetric-analysis procedure. A detection limit of approximately 0.03 mg CH_2O/m^2h is achieved with a 20.3 cm diameter monitor using a three-hour collection period. Measurements of the CH_2O emission rate from pressed-wood products show strong correlations between the surface-emission monitor and environmentally controlled chamber tests. Formaldehyde emission-rate measurements of UFFI encased in simulated exterior wall panels also show strong correlations between the surface monitor and an air-flow monitoring technique.

30332 **(CONF-830338—3) Preliminary results of a forty-home indoor air pollutant monitoring study.** Hawthorne, A.R.; Gammage, R.B.; Dudney, C.S.; Womack, D.R.; Morris, S.A.; Westley, R.R.; Gupta, K.C. (Oak Ridge National Lab., TN (USA)). 1983. Contract W-7405-ENG-26. 12p. NTIS, PC A02/MF A01. Order Number DE83009839.

From APCA specialty meeting on measurement and monitering of non-criteria toxic contaminants; Chicago, IL, USA (22 Mar 1983).

A detailed study of the pollutants found in forty homes in the Oak Ridge/Knoxville, Tennessee, area is being conducted. Formaldehyde measurements were made on a twice-per-month schedule using passive permeation monitors with a sampling period of 24 hours. In addition to the formaldehyde measurements, other pollutants, including volatile organics, particulates, nitrogen oxides, and carbon monoxide, were measured during a one-day visit to each house. Radon levels were measured during a one-day visit to each house. Randon levels were measured by an active monitor located in the house for a period of one week. Air infiltration rates and meteorological data were also recorded. Pollutant levels were generally below any applicable guidelines with the exception of radon and formaldehyde which were elevated in some of the houses. Results of the first phase of the monitoring study are presented.

30333 **(CONF-830438—1) Fine particles and precipitation: some case studies.** Johnson, S.A.; Sisterson, D.L.; Kumar, R. (Argonne National Lab., IL (USA)). 1983. Contract W-31-109-ENG-38. 5p. NTIS, PC A02/MF A01. Order Number DE83009591.

From American Association for Aerosol Research annual meeting; College Park, MD, USA (18 Apr 1983).

The chemical composition and mass loading of atmospheric fine-particle aerosols were examined, before, during, and after 25 individual precipitation events during a 12-month period. The submicrometer (0.3 to 1.0 μm) aerosol particles were collected using a modified Lundgren cascade impactor, and analyzed using Fourier-transform infrared absorption spectroscopy. In several cases where the precipitation was not accompanied by a frontal passage or other means of air mass change, two types of fine-particle aerosol behavior were observed. In one, the concentration of aerosol particles was reduced during the rain, but the concentration recovered quickly after the event. In the other, the aerosol particle concentrations increased during or after the rain, so that the precipitation

event was an apparent source of particles in the 0.3 to 1.0 μm size range. The chemical composition of the aerosol particles was also affected by the precipitation, leading to changes in the ammonium sulfate content of the aerosols, which changes were not always similar to the changes in the particles' mass loading. The meteorology associated with each precipitation event was examined in detail to determine the factors responsible for the observed behavior of the aerosol particles. The first type of behavior, a decrease in aerosol mass loading during the precipitation but recovery afterwards, is illustrated. The decrease could be attributed to the precipitation scavenging the particles locally; the subsequent recovery was caused by advection of other portions of the same air mass to the sampling location. The second type of behavior, an increase in the particle concentrations during or after the precipitation, is shown. An example of a decrease in ammonium sulfate in the particles simultaneous with an increase in the particle mass loading is shown.

30334 **(JEN—514) Quantitative determination of alpha-quartz in airbone dust samples by X-ray diffraction.** Bayon, A.; Roca, M. (Junta de Energia Nuclear, Madrid (Spain)). 1982. 16p. (In Spanish). NTIS (US Sales Only), PC A02/MF A01. Order Number DE83701539.

The quantitative determination by X-ray diffractometry of alpha-quartz in airbone respirable dust samples on silver membrane filters is considered. A cobalt anode X-ray tube is employee. NiO is used as internal standard in order to compensate for both the variations of specimen absorption and the effect due to the nonuniformity of the incident X-ray beam and to the incomplete homogeneity on the filters of samples and standards.

30335 **(LIS—19) Telemetric imission system TEMES.** (Landesanstalt fuer Immissionsschutz des Landes Nordrhein-Westfalen, Essen (Germany, F.R.)). 1982. 45p. (In German). Available from Landesanstalt fuer Immissionsschutz des Landes Nordrhein-Westfalen, Essen (Germany, F.R.).

The telemetric air quality measurement grid TEMES and its measurement tasks are elucidated taking into account the existing air quality control legislation. The technical description begins at the point of generation of the measurement data, covers all data transmission paths and includes the central station of the measurement grid at the Landesanstalt fuer Immissionsschutz (LIS) in Essen. The portrayal of TEMES focuses on the measurement technology. With regard to data processing only those aspects and details are discussed which are essential for the understanding of the measurement system.

30336 **(PB—83-148759) Remote tropospheric SO_2: cloud transport of reactive sulfur emissions.** Chatfield, R.B. (National Center for Atmospheric Research, Boulder, CO (USA)). 1982. 244p. NTIS, PC A11/MF A01.

Model simulations suggest that reactive sulfur gases emitted from the land or ocean surface can produce upper tropospheric sulfur dioxide at the levels of 80 plus or minus 30 pptv measured over the remote oceans. Emissions of 20-40 Tg(S)/yr of dimethyl sulfide, hydrogen sulfide, carbon disulfide, or more reactive species appear sufficient to explain this SO_2. Previously published estimates based on traditional K(z) theory suggest 1/6 to 1/30 as much SO_2 since they do not simulate the effects of rapid, but intermittent, convective transport. Further results indicate the importance of the possible transport, rainout, or reactions of peroxides; these appear to be as important as NO/sub x/ concentrations in determining tropical OH radical concentrations. Implications of this work for the description of O_3, NO/sub x/, SO_2 and other species in the tropics and mid-latitudes are briefly mentioned.

30337 **The ocean: major sink for fossil fuel CO_2.** Tsung-Hung, P. (Environmental Sciences Div. Oak Ridge National Lab. Oak Ridge, Tennessee 37830). *Energy (Stamford, Connecticut);* **7**: No. 4, 18-19(Sum 1982).

The ocean is a major sink for fossil fuel CO_2. Although its capacity for taking up fossil fuel CO_2 is large, the kinetics of CO_2 in the ocean does not allow an equilibrium to be established on a time scale of a few hundred years. The amount of fossil fuel CO_2 taken up by the ocean since the industrial revolution is mainly estimated by a numerical ocean model. Results indicate that the ocean is indeed a major sink, but some other sinks may be required to balance the carbon budget.

30338 **High-temperature-high-pressure cascade impactor design, performance, and data analysis methods.** Newton, G.J.; Carpenter, R.L.; Cheng, Y.S.; Barr, E.B.; Yeh, H.C. (Lovelace Biomedical and Environmental Research Inst., Albuquerque, NM). *Journal of Colloid and Interface Science;* **87**: No. 1, 279-290(May 1982).

A high-temperature - high-pressure, seven-stage cascade impactor has been designed, built, calibrated, and used to obtain size-classified samples of entrained fly ash from process streams of a pressurized low Btu coal gasifier. The cascade impactor was designed for an effective cutoff diameter (ECD) range of 12 μm down to about 0.5 μm aerodynamic diameter. Methods for calculating gas mixture viscosity, density, and mean free path have been developed and used to calculate impactor stage characteristics at operating temperatures and pressures for the gas mixture sampled. Process stream conditions were 400 to 700°C and 900 to 1370 kPa. The measured size distribution at stream conditions indicated a mass median aerodynamic diameter (MMAD) of 2.88 +- 0.47 μm with a geometric standard deviation (σ/sub g/) of 2.35 +- 0.35.

30339 **The MAP3S/RAINE precipitation chemistry network: statistical overview for the period 1976-1980.** *Atmospheric Environment;* **16**: No. 7, 1603-1631(1982).

This paper presents a basic statistical summary of the initial 3 1/2 year operating period of the MAP3S/RAINE precipitation chemistry network. The overview considers statistical features of the precipitation event data base, including temporal and variable-pair behavior and spatial (site-to-site) relationships. Seasonal variations in concentrations of the species total sulfur, SO_2, free hydrogen ion and NH_4^+ are easily identifiable from both event and monthly average time trend analyses. Species-pair correlations are generally strong and positive among the major ionic species total S, nitrate, free hydrogen and ammonium; variations from this trend at individual sites can be related to geographical location. Though reasonable coherency is exhibited in site-to-site correlation analyses, the questions of proper averaging time and network density make interpretation of spatial statistics difficult. It is anticipated that this summary will be a directly useful resource for wet-deposition assessment in the northeastern United States, and should compose a convenient starting point for more detailed analysis by the extended research community.

30340 **Oxidation of SO_2 in droplets which contain soot particles.** Benner, W.H.; Brodzinsky, R.; Navakov, T. (Lawrence Berkeley Lab., CA). *Atmospheric Environment;* **16**: No. 6, 1333-1339(1982). Contract W-7405-ENG-48.

A laboratory fog chamber was construced in which water droplets or droplets containing soot particles could be exposed to SO_2. For wet particles exposed to 0.007 ppM < $[SO_2]$ < 222 ppM, the maximum experimentally observed carbon-normalized rate of particulate sulfate formation was $d[SO_4^{2-}/C]dt = 8 \times 10^{-6}$(g SO_4^{2-})(g C^{-1})s^{-1}. The rate expression, $-d[S(IV)]/dt = k[C] \times \alpha[S(IV)]^2/1 + \beta[S(IV)] + \alpha[S(IV)]^2$ was determined for the reaction. Under atmospheric conditions, this rate expression indicates that the effective order for the oxidation of S(IV) depends on environmental conditions and ranges between 0.1 and 1.6.

30341 **Inhalation exposure chamber designed for animal handling.** Brown, M.D.; Moss, O.R. (Battelle Pacific Northwest Labs., Richland, WA). *Laboratory Animal Science;* **31**: No. 6, 717-720(Dec 1981). Contract AC06-76RL01831.

A whole-body inhalation exposure chamber was designed and constructed that provided for uniform distribution of aerosols within the chamber and facilitated animal care. Animals were permanently housed in the chamber while on experiment. The entire chamber was sanitized in our cagewashing unit. Animals and their feed were easily observed since cages were mounted in pull-out drawers. The chamber accommodated 360 mice, 196 rats, 312 hamsters, 60 guinea pigs, or 30 rabbits. A special feature of the design was that cages and their associated excreta pans were equally spaced from chamber walls and arranged in vertical columns which

were offset. This arrangement prevented excreta from dropping on animals in lower tiers.

30342 **Predictions for particle deposition on natural waters.** Slinn, S.A.; Slinn, W.G.N. (Battelle Pacific Northwest Labs., Richland, WA). *Atmospheric Environment;* **14**: 1013-1016(1980). Contract AM06-76RL02227.

Deposition velocity predictions, for aerosol particles depositing on natural waters, are obtained by modifying earlier theory for deposition on smooth, solid surfaces. If particle growth by water vapor condensation occurs in the humid region adjacent to the air/water interface then the deposition velocity for particles with (dry) radii near 1 μm is predicted to be essentially independent of particle size and equal to the limiting value set by atmospheric turbulence. That is, for these particles, v/sub d/ ≃ u/sub */^{2}/anti u = C/sub D/anti u where (for open waters, constant wind, near neutral stability, and a 10m reference height) the drag coefficient C/sub D/ = (1.3 +- 0.3) x 10^{-3}.

5003 Radioactive Materials Monitoring And Transport

REFER ALSO TO CITATION(S) 30362

30343 (ANL—82-65-Pt.2, pp 97-103) **Measurements of the deposition rates of radon daughters on indoor surfaces.** Wang, H. (North China Inst. of Radiation Protection, Yangku); Essling, M.A.; Toohey, R.E.; Rundo, J. Nov 1982. NTIS, PC A11/MF A01.

In Radiological and Environmental Research Division, Center for Human Radiobiology. Annual report, July 1981-June 1982.

The deposition rates of radon daughters on indoor surfaces have been measured by exposing the window of a proportional counter to the air of a house with high concentrations of radon and its daughters. Deposition velocities for unattached ^{218}Po (RaA) and ^{214}Pb (RaB) of approximately 4 mm sec^{-1} were obtained by dividing the deposition rates by the concentrations of unattached daughters in the air. These results agree with those obtained by other workers but are dependent on the assumptions made about the fractions of the daughters which are attached to the atmospheric aerosol.

30344 (ANL—82-65-Pt.2, pp 104-106) **Some measurements of the equilibrium factor for radon daughters in houses.** Toohey, R.E.; Essling, M.A.; Wang, H.; Rundo, J. Nov 1982. NTIS, PC A11/MF A01.

In Radiological and Environmental Research Division, Center for Human Radiobiology. Annual report, July 1981-June 1982.

Because the radiation dose to the lung from environmental radon is due almost entirely to the inhalation of the short-lived daughter products, measurements of radon levels alone are not sufficient to determine the dose. Typically the activities of the daughter products in air are not in daughters themselves. The working level (WL) was introduced as a convenient unit to overcome this problem in uranium mines, and it is also applicable to other environments where radiation dosimetry is the principal concern. Since it is easier to determine the radon concentration than the working level, the task of determining lung doses would be simplified if those factors which determine equilibrium could be identified and their effects quantified. In order to do this, simultaneous measurements of radon concentrations and working levels must be made in houses under a variety of conditions. In addition, parameters that may affect the equilibrium factor, such as aerosol concentration and ventilation rate, must also be identified and monitored. Although the effects of such parameters may be best determined under controlled conditions in a laboratory, the results must be validated by measurements in houses. This paper describes these measurements.

30345 (UCRL—53280) **Atmospheric release advisory capability pilot project at two nuclear power plants and associated state offices of emergency preparedness. Final report.** Rosen, L.C. (Lawrence Livermore National Lab., CA (USA)). Jan 1983. Contract W-7405-ENG-48. 49p. NTIS, PC A03/MF A01. Order Number DE83009710.

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A project to demonstrate the feasibility of utilizing Atmospheric Release Advisory Capability (ARAC) limited service with commercial nuclear power plants and their associated state offices of emergency preparedness is discussed. Preliminary planning, installation and testing of the ARAC site facilities at Indian Point Nucler Power Station, New York State; at New York State Office of Emergency Preparedness, Albany, New York; at Rancho Seco Nuclear Generating Station, California; and at the State of California Office of Emergency Services, Sacramento, California, are summarized. ARAC participation in the Robert E. Ginna nuclear generating plant accident in New York on January 25, 1982, is discussed. The ARAC system is evaluated with emphasis on communications, the suite of models contained within the ARAC system, and the staff. The implications of this project in designing the next-generation ARAC system to service federal and state needs are assessed.

30346 **Uncertainty estimates for site-specific atmospheric diffusion parameters.** Miller, C.W. (Oak Ridge National Laboratory, Oak Ridge, TN 37830). *Transactions of the American Nuclear Society;* **41**: 74(Jun 1982). (CONF-820609—).

From American Nuclear Society annual meeting; Los Angeles, CA, USA (6 Jun 1982).

30347 **Resolution of a unique transport situation with tritium air sampling.** Carfango, D.G.; Farmer, B.M.; Lacy, V.C. (Monsanto Research Corporation, P.O. Box 32, Miamisburg, OH 45342). *Transactions of the American Nuclear Society;* **41**: 72(Jun 1982). (CONF-820609—).

From American Nuclear Society annual meeting; Los Angeles, CA, USA (6 Jun 1982).

5005 Site Resource And Use Studies

REFER ALSO TO CITATION(S) 29250, 29251, 29252, 29253, 30375, 30397

5006 Regulations

30348 **(CONF-811212—18) Industrial energy use, nonattainment, and the Clean Air Act reauthorization.** Grogan, P.J.; Garvey, D.B.; Streets, D.G. (Argonne National Lab., IL (USA)). 1981. Contract W-31-109-ENG-38. 13p. NTIS, PC A02/MF A01. Order Number DE83009008.

From 4. international conference on alternative energy sources; Miami Beach, FL, USA (14 Dec 1981).

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Revisions to the Clean Air Act have been addressed in the recent session of the U.S. Congress and debate is likely to continue into 1982. One issue which will receive attention is air-quality regulations required of manufacturing facilities in nonattainment areas. As a major source or projected energy consumption, manufacturing industries have the potential to be significantly affected by changes in existing air-quality regulations required of manufacturing facilities in nonattainment areas. As a major source of projected energy consumption, manufacturing industries have the potential to be significantly affected by changes in existing air-quality regulations. The spatial aspects of industrial energy use in relation to nonattainment areas are, therefore, an important factor in describing the impacts of potential revisions of the Clean Air Act on the manufacturing sector. The purpose of this paper is to provide estimates of the percentage of industrial energy use located in nonattainment areas and to discuss the implications of the patterns of industrial energy use for air quality policy.

30349 **(DOE/EP/12086—T1) Economic assessment of Best Available Treatment and Best Conventional Treatment Waivers for selected industries. Final report.** Cover, A.P.; Hall, T.A.; Harner, D.D.; McCloskey, M.H. (Radian Corp., Austin, TX (USA)). 7 Feb 1983. Contract AC01-82EP12086. 47p. NTIS, PC A03/MF A01. Order Number DE83006539.

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The purpose of this report is to estimate the nationwide incremental cost savings for selected industries as a result of a change in the Clean Water Act which would allow Best Available Technology waivers based on existing water quality levels. A three part approach was followed: review of published effluent guideline documents for basic cost data; estimation for selected industries of potential nationwide savings resulting from a waiver; and identification of a case study methodology for more detailed analyses when necessary. For completion of the second element identified above, assistance and information were provided by Energy Division personnel of Oak Ridge National Laboratory (ORNL). ORNL's existing data bases which identify the distribution of relatively clean water and define industry locations formed the basis for the region specific aspects of this study.

51 ENVIRONMENTAL SCIENCES, TERRESTRIAL

30350 **An American scientist visits the Altamira cave in northern Spain.** Wilkening, M. (New Mexico Inst. of Mining and Tech., Socorro). *New Mexico Journal of Science;* **21**: No. 2, 1-4(Dec 1981). Contract AS04-78ET05369.

The Altamira Cave is internationally known for its remarkable Stone Age paintings. It is located in the brow of a hill overlooking the village of Santillana del Mar which is nestled among green rolling hills near the coast of northern Spain. This report gives a brief description of the Cave and its paintings, the nature of the deterioration that has resulted in the closing of the cave to tourists, and the scientific studies being undertaken to help preserve the paintings.

5101 Basic Studies

REFER ALSO TO CITATION(S) 29247, 30386

30351 (LA—9479-PR, pp 135) **Biotelemetry studies on Elk-updates.** White, G.C.; Thiel, D.K. Oct 1982. NTIS, PC A08/MF A01.

In Los Alamos Life Sciences Division's biomedical and environmental research programs. Progress report, January-December 1981.

The movements of Rocky Mountain elk (Cervus elaphus nelsoni) in the eastern Jemez Mountains of north-central New Mexico have been studied from 1978 to 1981. Seventy elk have been trapped, marked, and released; sixty of these animals were radio collared. As of October 1981, twenty-four collared animals were being monitored. The others have been hunter-killed or poached, radio failures, or unknown disappearances. There were two significant occurrences during 1981. Due to a timber sale on the eastern slopes of Cerro Grande and Pajarito Mountain, and a minor outbreak of the disease Elaeophora schneideri, there was a change in migration routes.

30352 (LA—9479-PR, pp 136) **Nutritional ecology of elk at the LA/NERP.** Kovacic, D.A. Oct 1982. NTIS, PC A08/MF A01.

In Los Alamos Life Sciences Division's biomedical and environmental research programs. Progress report, January-December 1981.

The present study is a continuation of work to study the elk population dynamics on LA/NERP lands following the La Mesa fire. In this phase of the ongoing project, researchers are studing post-fire successional and nutrient dynamics. Researchers will determine how these dynamics relate to elk population carrying capacity and animal condition.

30353 **Small mammals of a bitterbrush-cheatgrass community.** Gano, K.A.; Rickard, W.H. (Battelle Pacific Northwest Lab., Richland, WA). *Northwest Science;* **56**: No. 1, 1-7(1982). Contract AC06-76RL01830.

Small mammals were live-trapped in burned and unburned segments of a bitterbrush-cheatgrass community during the years 1974-1979. Results indicate that the shrub-dominated unburned area supports about three times as many small mammals as the cheatgrass-dominated burned area. Species composition was similar in both areas with the exception of one ground squirrel (Spermophilus townsendii) captured on the unburned area. Other species caught were the Great Basin pocket mouse (Perognathus parvus), deer mouse (Peromyscus maniculatus), northern grasshopper mouse (Onychomys leucogaster), and the western harvest mouse (Reithrodontomys megalotis).

30354 **Self-revegetation of disturbed ground in the deserts of Nevada and Washington.** Rickard, W.H.; Sauer, R.H. (Battelle Pacific Northwest Lab., Richland, WA). *Northwest Science;* **56**: No. 1, 41-47(1982). Contract AC06-76RL01830.

Plant cover established without purposeful soil preparation or seeding was measured on ground disturbed by plowing in Washington and by aboveground nuclear explosions in Nevada. After a time lapse of three decades in Washington and two decades in Nevada, fewer species were self-established on the disturbed ground than the nearby undisturbed ground. Alien annual plants were the dominants on the disturbed ground. Cheatgrass (Bromus tectorum) dominated abandoned fields in Washington, and filaree (Erodium cicutarium) dominated disturbed ground in Nevada. Perennial grasses and shrubs appeared to be more successful as invaders in Nevada than in Washington. This distinction is attributed to the superior competitive ability of cheatgrass in Washington.

5102 Chemicals Monitoring And Transport

REFER ALSO TO CITATION(S) 28871, 28872, 30589

30355 **(CEA-R—5192) Study of the origin of mercury present in the Papeete Lagoon (Tahiti, French Polynesia).** Debie, E.; Raymond, A.; de Nardi, J.L. (CEA Centre d'Etudes Nucleaires de Fontenay-aux-Roses, 92 (France)). Oct 1982. 35p. (In French). NTIS (US Sales Only), PC A03/MF A01. Order Number DE83750440.

Water mercury levels in the Papeete (Tahiti, Fr. Polynesia) area have been found to be of telluric origin, since industrial activities remain low. The observed concentrations, slightly above values found in the literature for the South Pacific, can be explained by physical and geographic considerations. However, mercury levels remain within acceptable limits for public health.

30356 (LA—9479-PR, pp 127-129) **Assay for bioavailability of uranium mill tailings contaminants.** Dreesen, D.R.; Cokal, E.J.; Maez, M.A. Oct 1982. NTIS, PC A08/MF A01.

In Los Alamos Life Sciences Division's biomedical and environmental research programs. Progress report, January-December 1981.

The results of plant uptake assay experiments have indicated that appreciable concentration ratios for bioavailable contaminants are obtained for plants grown in tailings for one month compared with controls. The apparent differences in root and shoot content for many elements illustrate the need for further refinement in experimental methods to better determine if some contaminants are fixed in the roots. The results of the most recent assays indicate a very complex relationship between contaminant uptake and plant species, tailings type, and the element of interest. It is clear that knowledge of total or extractable elemental contents cannot be directly related to uptake. In addition, the assimilation and translocation of contaminants by one species can not necessarily be extrapolated to other species.

30357 (LA—9479-PR, pp 129-132) **Subsurface transport of contaminants from energy process waste leachates.** Wangen, L.E.; Stallings, E.A. Oct 1982. NTIS, PC A08/MF A01.

In Los Alamos Life Sciences Division's biomedical and environmental research programs. Progress report, January-December 1981.

A number of inorganic components are present in leachates from energy processing wastes at concentrations high enough to contaminate water supplies if the leachates are added in sufficient quantities. Trace contaminants often present at higher then acceptable concentrations include As, B, Cl, F, Mn, Mo, Se, NO_3, Ni, and

Cd. The environmental transport and effluent breakthrough curves for these species are developed for 4 subsoils and 2 soil mineral components. (DLS)

30358 **(ORNL/TM—8588) Hydrogen and sulfate additions to the forest floor and their effects on soil and litter arthropods.** Craft, C.B.; Webb, J.W. (Oak Ridge National Lab., TN (USA)). Apr 1983. Contract W-7405-ENG-26. 93p. NTIS, PC A05/MF A01. Order Number DE83010452.

Portions are illegible in microfiche products. Original copy available until stock is exhausted; Thesis. Submitted by C.B. Craft to Univ. of Tennessee, Knoxville.

Acid rain is known to have a detrimental effect on many freshwater systems. Its effects on terrestrial systems are poorly known. The study was conducted to determine the effects of neutral and acidic SO_4 deposition on soil and litter arthropods and the consequent effects on available P. The specific objectives were to pinpoint functional groups that are affecte by increased acid deposition and to assess the impact on both direct (soil arthropods) and indirect (soil pH and Al) factors governing soil P. By analyzing the effects of H and SO_4 deposition on arthropod trophic structure, it becomes possible to apply the results obtained in this study to other ecosystems that are impacted by acid rain.

30359 **(PNL—4614) Field evaluation of hazardous waste site bioassessment protocols.** Thomas, J.M.; Cline, J.F.; Cushing, C.E.; McShane, M.C.; Rogers, J.E.; Rogers, L.E.; Simpson, J.C.; Skalski, J.R. (Pacific Northwest Lab., Richland, WA (USA)). Apr 1983. Contract AC06-76RL01830. 112p. NTIS, PC A06/MF A01. Order Number DE83010355.

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The goals were: (1) determine the variability (both within and between laboratories) for the various bioassay procedures using contaminated soil samples from the Rocky Mountain Arsenal (RMA); (2) assess variability within and between plots for several assessment techniques (for sampling small mammals, plants, insects including honeybees and microarthropods) so that field studies could be designed to detect a defined biotic change; (3) establish three field plant transects which are apparently (a) contaminated, (b) appear contaminated and (c) could serve as a control; (4) assess the feasibility (in the laboratory) of using Basin F water to contaminate RMA soil artificially, and to supply information for the design of a field plot study in 1983; (5) attempt to obtain preliminary data on any promising field or laboratory bioassessment techniques not currently mentioned in the statement of work; and (6) obtain field data to assess the ecological status of RMA lakes and compare these observations to results from bioassessment testing.

30360 **Cycling of organic and inorganic sulphur in a chestnut oak forest.** Johnson, D.W. (Oak Ridge National Lab., TN); Henderson, G.S.; Huff, D.D.; Lindberg, S.E.; Richter, D.D.; Shriner, D.S.; Todd, D.E.; Turner, J. *Oecologia;* **54**: 141-148(1982). Contract W-7405-ENG-26.

Sulfur (S) cycling in a chestnut oak forest on Walker Branch Watershed, Tennessee, was dominated by geochemical processes involving sulfate. Even though available SO_4^{2-} was present far in excess of forest nutritional requirements, the ecosystem as a whole accumulated 60% of incoming SO_4-S. Most (90%) of this accumulation occurred by SO_4^{2-} adsorption in sesquioxide-rich subsurface soils, with a relatively minor amount accumulating and cycling as SO_4^{2-} within vegetative components. Organic sulfates are thought to constitute a large proportion of total S in surface soils, also, and to provide a pool of readily mineralized available S within the ecosystem.

30361 **Development of a method for determining the leachability of organic compounds from solid wastes.** Warner, J.S.; Hidy, B.J.; Jungclaus, G.A.; McKown, M.M.; Miller, M.P.; Riggin, R.M. (Battelle, Columbus Lab, Ohio, USA). *American Society for Testing and Materials, Special Technical Publication;* 40-60(1981). (CONF-810185—).

From ASTM conference on hazard solid waste test; Ft. Lauderdale, FL, USA (14 Jan 1981).

A method for assessing the potential mobility of purgeable pollutants from solid waste materials has been developed. The leaching media studied included distilled water, Acetate and citrate buffers, reducing agents and surfactants. The leachates were analyzed both for metals and for organic compounds. 16 refs.

5103 Radioactive Materials Monitoring And Transport

REFER ALSO TO CITATION(S) 29169, 29170, 29171, 29218, 29246, 29254, 29256, 29257, 30317

30362 **(CONF-8108160—1) Environmental impact of uranium mining and milling: an American view.** Momeni, M.H. (Argonne National Lab., IL (USA)). 18 Aug 1981. Contract W-31-109-ENG-38. 13p. NTIS, PC A02/MF A01. Order Number DE83009596.

From American Chemical Society conference on environmental impact of uranium mining and milling; Detroit, MI, USA (18 Aug 1981).

The radiation dose rates to man from uranium milling activities are discussed. The sources of radiation, the radioisotopes involved, and the environmental exposure pathways are described. Risks of cancer to exposed individuals are presented and recommendations made for mitigation of contamination. (ACR)

30363 **(DP—1644) Environmental behavior of technetium-99.** Turcotte, M.D.S. (Du Pont de Nemours (E.I.) and Co., Aiken, SC (USA). Savannah River Lab.). Dec 1982. Contract AC09-76SR00001. 62p. NTIS, PC A04/MF A01. Order Number DE83010342.

This report presents a review of the literature on technetium-99. The chemical and physical properties of some technetium compounds are considered, and a discussion of possible source terms is included. Literature on the environmental behavior of technetium is presented, including its behavior in the bodies of animals and humans. The primary sources of Tc-99 in the environment are fallout from atomic detonations and releases from nuclear fuel reprocessing plants. The environmental behavior of technetium-99 has been studied predominantly with respect to movement in soil and accumulation in plants. There is a surprising scarcity of data on behavior of Tc-99 in the atmosphere and in aquatic systems. Additional work needs to be conducted in these two areas to determine behavior and to acquire baseline concentration data. Much of the soil work has produced contradictory results. In-depth studies of holdup mechanisms for Tc-99 in both geological repositories and soil need to be conducted. Since plants represent a potential bioaccumulation of Tc-99, plant uptake studies of Tc-99 under field conditions also need to be done.

30364 (LA—9479-PR, pp 136-138) **Investigation of radionuclide concentrations in tissues of elk utilizing Los Alamos National Laboratory lands.** Meadows, S.; Salazar, J. Oct 1982. NTIS, PC A08/MF A01.

In Los Alamos Life Sciences Division's biomedical and environmental research programs. Progress report, January-December 1981.

Five Rocky Mountain elk (Cervus elaphus nelsoni) were collected on Los Alamos National Laboratory land and various tissues were sampled and analyzed for concentrations of ^{137}Cs, ^{90}Sr, ^{239}Pu, and U. Samples of elk tissue were also collected from hunter kills in Cuba, New Mexico and similarly analyzed to provide background data for comparison with the Laboratory samples. Expected doses (mrem) to a human consumer from elk meat were then calculated using the reported concentrations.

30365 (LA—9479-PR, pp 141-142) **Surficial contamination of vegetation by soil.** Dreicer, M. Oct 1982. NTIS, PC A08/MF A01.

In Los Alamos Life Sciences Division's biomedical and environmental research programs. Progress report, January-December 1981.

To assess the importance of resuspension of soil onto plant surfaces by raindrop splash as a pathway for contaminants to enter the food chain, the resuspension and retention of soil onto tomato plant surfaces was studied. Almost all the ^{239}Pu found in plant samples is attributable to the splashup mechanism, and it is concluded that this pathway can be important in food chain analysis. (DLS)

30366 **(ORNL/TM—8597) Radium-226 in drinking water and terrestrial food chains: a review of parameters and an estimate of potential exposure and dose.** Watson, A.P.; Etnier, E.L.; McDowell-Boyer, L.M. (Oak Ridge National Lab., TN (USA)). Apr 1983. Contract W-7405-ENG-26. 44p. NTIS, PC A03/MF A01. Order Number DE83010446.

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Environmental transport of ^{226}Ra from geological formations to drinking water and from soil to vegetation, meat and milk were quantitatively analyzed following a review of literature. Both natural and industrial sources were investigated. Particular attention was given to references specific for the phosphate-mining region of southwestern Florida. Literature sources have been interpreted to develop concentration factors describing terrestrial food-chain transport. Unweighted means and associated ranges of concentration factor values, representing averages of data collected over a variety of environmental conditions, soil types, and chemical forms, are also provided. Annual human exposure and 50-year dose commitments to bone, lung, liver, kidney and whole body were estimated by assuming mean concentration factors as well as annual food and water consumption rates.

30367 **Relative amount of organic and inorganic tritium present in the tissues of animals exposed to tritium through their drinking water or through their diet.** Commerford, S.L. (Brookhaven National Lab., Upton, NY (USA)). *Annales de l'Association Belge de Radioprotection;* 7: No. 3-4, 307-316(1982).

From International symposium on radioecology; Wageningen (Netherlands) (28 - 30 Jun 1982).

Portions are illegible in microfiche products3 refs.

Most organic tritium in the tissues of animals is present as water and nearly all such tritium atoms exchange rapidly with one another and thus become uniformly distributed throughout all cells and tissues. Consequently, the radiation absorbed by the nuclei of cells due to radioactive decay of these tritium atoms is easily calculated. Most organic tritium is present in the form on nucleic acids, carbohydrates, lipids and proteins. This tritium does not exchange and is not uniformly distributed. Determination of the radiation absorbed by nuclei from tritium in these components is much more difficult. Calculations show that when exposure to tritium is through the drinking water, the amount of organic tritium is small compared to the amount of inorganic tritium and contributes little to the radiation absorbed by cell nuclei. When exposure to tritium is through dietary proteins, however, the level of organic tritium exceeds that of inorganic tritium and makes a major contribution to the radiation absorbed.

30368 **The non-fisheries biological resources of the Hanford reach of the Columbia River.** Rickard, W.H.; Hanson, W.C.; Fitzner, R.E. (Battelle Pacific Northwest Lab., Richland, WA). *Northwest Science;* 56: No. 1, 62-76(1982). Contract AC06-76RL01830.

The Hanford Reach is the only undammed segment of the Columbia River in the United States upstream from Bonneville Dam. The non-agricultural and non-recreational land-use policies imposed by the Department of Energy have permitted the Hanford Site to function as a refugium for wildlife for 35 years. The protection offered by the Hanford Site has been especially important for the Bald Eagle (Haliaeetus leurocephalus), mule deer (Odocileus hemionus), coyote (Canis latrans), and resident Great Basin Canada Goose (Branta canadensis moffitti). Island habitats are especially important for nesting geese and for mule deer fawning. Coyotes are important predators upon nesting geese and mule deer fawns. Salmon carcasses are an important winter food for Bald Eagles. Riparian plant communities along the Columbia River have been changing in response to changing water level fluctuations largely regulated by power generation schedules at upstream hydroelectric dams. There are no studies presently established to record the response of Columbia River shoreline plant communities to these kinds of fluctuating water levels. The existing information is summarized on birds and mammals closely allied with the Hanford Reach of the Columbia River. High trophic level wild animals are discussed as indicators of chemical contamination of food chains.

5105 Site Resource And Use Studies

REFER ALSO TO CITATION(S) 28878, 29094, 29250, 29251, 29252, 29444, 30397, 30398, 30399, 30400, 30455

30369 **(DOE/SR/01072—5) Human occupation along the Steel Creek floodplain: results of an intensive archeological survey for the L area reactivation project, Savannah River Plant, Barnwell County, South Carolina. Research manuscript series 173.** Hanson, G.T. Jr.; Brooks, R.D.; White, J.W. (South Carolina Univ., Columbia (USA). Inst. of Archeology and Anthropology). Dec 1981. Contract AS09-78SR01072. 175p. NTIS, PC A08/MF A01. Order Number DE83010303.

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An intensive archeological survey of the Steel Creek terrace and floodplain system below the L Reactor Area was conducted for the purpose of identifying the archeological resources and assessing their significance within this portion of the Savannah River Plant. The survey was required as part of the project plan for the reactivation of the L Reactor in order to comply with the requirements of the National Environmental Policy Act of 1969, Executive Order 11593, the National Historic Preservation Act of 1966, as amended in 1980, and the Archeological and Historic Preservation of 1974. In accordance with these laws, a complete archeological survey of the potential impact area along Steel Creek was accomplished, resulting in the recovery of data for 18 archeological sites. According to the evidence recovered from the 18 sites, the Steel Creek watershed's occupation extends to at least 8000 B.P. Site 38BR55 is considered eligible for nomination to the National Register of Historic Places. Recommendations for the protection of this site and of four historic earthen structures in the floodplain are presented, along with a summary of the archeological background, methods, environmental reconstruction, research results, and recommendations resulting from the survey of the Steel Creek terrace and floodplain system.

30370 **(DOE/SR/01072—6) Intensive archeological survey of the proposed Saltcrete area of the Defense Waste Processing Facility, Savannah River Plant, Aiken County, South Carolina. Research manuscript series 172.** Brooks, R.D. (South Carolina Univ., Columbia (USA). Inst. of Archeology and Anthropology). Jun 1981. Contract AS09-78SR01072. 14p. NTIS, PC A02/MF A01. Order Number DE83009450.

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An intensive archeological survey of the proposed Saltcrete (200-Z) area of the Defense Waste Processing Facility on the Savannah River Plant, Aiken County, South Carolina was conducted. The purpose was to locate, describe and assess the archeological resources within the proposed construction area and to provide the Department of Energy with the recommendations as to the significance of the resources. This report presents a summary of the background, methods, results and recommendations resulting from the Saltcrete area intensive survey.

30371 **(DOE/SR/01072—9) Close out report for the archeological investigations on the Savannah River Plant.** Hanson, G.T. Jr. (South Carolina Univ., Columbia (USA). Inst. of Archeology and Anthropology). Mar 1983. Contract AS09-78SR01072. 45p. NTIS, PC A03/MF A01. Order Number DE83008916.

A brief review is presented of the activities of the Savannah River Plant Archaeological Research Program. One hundred forty-five archaeological sites were investigated and recorded in six surveys. These surveys are (1) the survey of the proposed independent spent fuel storage facility site; (2) the survey of the proposed defense waste processing facility; (3) the survey of the proposed Saltcrete area of the defense waste processing facility; (4) the survey of the Steel Creek for the L-Area reactivation project; (5) the general inventory of Savannah River Plant archaeological sites; and (6) the stratified, random sampling of the Four Mile Creek watershed. Also included is a survey of the remnant and relocated cemetaries present on the site and a study of the sedimentological history of the Savannah River Plant flood plain. (ACR)

30372 (LA—9479-PR, pp 139-140) **Habitat types in the Pinon-Juniper woodland of northern New Mexico.** Barnes, F.J.; Cunningham, G.L. Oct 1982. NTIS, PC A08/MF A01.

In Los Alamos Life Sciences Division's biomedical and environmental research programs. Progress report, January-December 1981.

Pinon-juniper woodland is a major vegetation type in the United States, covering over 75,000 square miles of the southwest. The distribution of the trees species comprising pinon-juniper woodland has been documented, but the adaptive physiological mechanism that might explain such distribution has not been studied. The work in this study will lay the groundwork for such an ecophysiological investigation into the distribution of Pinus edulis and Juniperus monosperma, the two dominant tree species in the northern New Mexico pion-juniper woodland.

30373 (LA—9479-PR, pp 142) **Checklist of vascular plants of the Pajarito Plateau and adjacent Jemez Mountains.** Foxx, T.S.; Tierney, G.D. Oct 1982. NTIS, PC A08/MF A01.

In Los Alamos Life Sciences Division's biomedical and environmental research programs. Progress report, January-December 1981.

During the past three years, several studies have been carried out to determine the presence of rare, endangered, or threatened plant species within the confines of the Los Alamos National Environment Research Park. The third and final volume of this study was the compilation of a checklist of vascular plants of the Pajarito Plateau and adjacent Mountains. Using information gathered by Foxx and Tierney and other information sources, a checklist of 1000 species for the described area has been compiled.

30374 (ONWI—469) **Vegetative communities, Davis and Lavender Canyons, Paradox Basin, Utah: ecosystem studies.** (Bechtel Group, Inc., San Francisco, CA (USA)). Apr 1983. Contract AC06-76RL01830. 26p. NTIS, PC A03/MF A01. Order Number DE83011112.

The major vegetative communities of Davis and Lavender canyons located in southeastern Utah are characterized. The report identifies potential secondary impacts and appropriate mitigation options. The Davis Canyon and Lavender Canyon Study Area contains nine major vegetative communities: galleta-shadscale, juniper-blackbrush, juniper-shadscale-ephedra, shadscale-ephedra, grayia-shadscale, juniper, drywash, greasewood, and riparian. The natural recovery times of these communities are exceedingly long. Natural reinvasion of various species would take from 15 to 100 years. No threatened or endangered plant species were identified in the study area. Davis and Lavender canyons have been subject to off-road vehicle activity and extensive grazing. The plant communities may be subject to additional impacts as a result of increased human activity and off-highway activities such as camping, hiking, and hunting could result in changes in cover, composition, and frequency of plant species. Mitigation options for potential impacts include shuttle-busing workers to the site from the highway and fencing site access roads to prevent vehicles from leaving the roads.

30375 (PNE—481-Bk.1and2) **Environment of Cape Thompson region, Alaska.** Wilimovsky, N.J.; Wolfe, J.N. (eds.). (USAEC Division of Technical Information Extension, Oak Ridge, TN). 1966. 1305p. NTIS.

In 1958 the then US AEC authorized planning and studies for an experimental harbor excavation called Project Chariot. A site at the mouth of Ogotoruk Creek near Cape Thompson on the northwestern coast of Alaska was selected for detailed study. This report contains those detailed studies on the physical and biological environment of the Cape Thompson are necessary to establish an ecological baseline. (ACR)

5106 Regulations

REFER ALSO TO CITATION(S) 28872, 29261, 29751

52 ENVIRONMENTAL SCIENCES, AQUATIC

5201 Basic Studies

REFER ALSO TO CITATION(S) 30383, 30447

30376 **Mat-water phosphorus exchange in an acid bog lake.** Hooper, F.F.; Morris, L.S. (Univ. of Michigan, Ann Arbor). *Ecology;* **63**: No. 5, 1411-1421(Oct 1982).

The exchange of phosphorus between a bog lake and its surrounding Sphagnum mat and the fate of mat phosphorus entering the limnetic zone of a lake were studied by means of a series of mat-labeling experiments using ^{32}P, and by an analysis of water budgets of the lake and mat. A ^{32}P solution applied directly to the Sphagnum produced a labeled soluble but biologically refractory phosphorus fraction which persisted in the lake at the initial concentration level for >16 d. Labeling the interstitial water of the mat directly with ^{32}P produced a labeled particulate fraction which was biologically active and was quickly concentrated in the limnetic food web. Heavy rainfall flushed both labeled components into the lake. The pathway phosphorus takes to enter the lake from the mat was determined by temperature gradients in the mat and the degree of decomposition of the mat material. The maximum phosphorus concentrations in the mat were above a compacted zone at the 2-m depth. This maximum coincided with an open-water phosphorus maximum at 2 m, which indicated that there were frequent inputs of mat phosphorus to this stratum. The direction of net phosphorus movement was largely controlled by the water balance of the system. During periods of high precipitation, low temperatures, and low evapotranspiration, as was found in early spring, net phosphorus movement was toward the lake. During midsummer high evapotranspiration of the mat vegetation increased the storage capacity of the mat. This reduced phosphorus flow toward the lake so that net flow was often toward the mat. (JMT)

30377 **Genesis of bimodal size distributions in species cohorts.** DeAngelis, D.L.; Coutant, C.C. (Oak Ridge National Lab., TN). *Transactions of the American Fisheries Society;* **111**: 384-388(1982). Contract W-7405-ENG-26.

Explicit consideration of size distributions within animal population cohorts can be important, because distributions in size can result in qualitatively complex phenomena not anticipated from the usual averaging population models. For example, bimodal size distributions have been observed to develop in fish cohorts. A partial-differential-equation model is used to corroborate the hypothesis that such bimodality can be generated when available prey is a function of time and of size of the fish in the cohort.

5202 Chemicals Monitoring And Transport

REFER ALSO TO CITATION(S) 28866, 28869, 28871, 29052, 29095, 29443, 30355, 30357, 30361, 30390, 30577, 30589

30378 (AAEC/E—520) **Microbial ecology of Rum Jungle, III. Leaching behaviour of sulphidic waste material under controlled conditions.** Babij, T.; Goodman, A.; Khalid, A.M.; Ralph, B.J. (Australian Atomic Energy Commission Research Establishment, Lucas Heights). Dec 1981. 35p. NTIS (US Sales Only), PC A03/MF A01. Order Number DE83701492.

The discharge, into river systems, of acid and heavy metals generated by leaching of sulphidic waste materials at the abandoned opencut uranium mine at Rum Jungle, Northern Territory, is causing continuing pollution of the surrounding environment. The maximum effects of acid and microorganisms on samples from the overburden dump material, under defined and controlled environmental conditions, were assessed using reactor systems. These samples came from the overburden dump resulting from the mining of White's orebody. Similarly, the stability of tailings material under conditions of flooding and increasing acidity was determined. At ph

2.5, metals in White's dump material were solubilised by acid attack only, whereas at pH 3.5, bacterial activity (principally that of Thiobacillus ferrooxidans) generated acidity and contributed significantly to metal release. Under microaerophilic conditions Thiobacillus ferrooxidans continued to effect metal release from the ore, but did not produce further acidity. If White's overburden is returned to the acidic, flooded opencuts, complete solubilisation of the material will occur. The exclusion of oxygen from the dump will not necessarily stop bacterially catalysed leaching processes. Under highly aerated and agitated flooded conditions the tailings material was not active, except for copper release of about 2 g kg^{-1} ore at pH 4.0. The only deleterious element released by increasing acidity was copper, which was 100 per cent solubilised at pH 2.5. Uranium was always lss than 3 μg kg^{-1} ore, and lead was detected only at pH 2.5. Indigenous leaching bacteria did not develop.

30379 **(CRWR—64) Biodegradation of oil in ponds.** Harutunian, S.A.; Gloyna, E.F. (Texas Univ., Austin (USA). Center for Research in Water Resources). Aug 1970. 50p. Univ. of Texas at Austin, Center for Research in Water Resources, 10100 Burnet Road, Austin, TX 78758.

The treatment of crude oil in waste stabilization ponds was investigated. Particular emphasis was directed to the effects of settled oily sludges and surface oils on the performance of waste stabilization ponds. API separator bottoms and crude oil were applied separately to bottom sands in model ponds. The effect of these wastes at the bottom on the upper layers of water was investigated in detail. The effect of crude oil present in water on the dissolved oxygen (DO) measurements by the DO analyzer was investigated. The effect of anaerobic zones on the treatment of crude oil by waste stabilization ponds was also considered in detail. Parameters considered in this study were: BOD, COD, suspended solids, hydrogen ion concentration (pH), measurable dissolved oxygen (DO) and temperature. Microscopic examinations were made to determine the predominant algal population. The oil released from the bottom of the ponds amounted to about 25 percent of the total pollutants present in the ponds. The 25 percent contribution of organics was obtained from a pond designed to treat 50 pounds of ultimate BOD per acre per day (50 lb BODu/acre/day), influent loading and 0.1 pound of ultimate BOD per square foot (0.1 lb of BOD/u/square ft) of bottom sediments.

30380 **(CRWR—121) Biogeochemical cycling of carbon, nitrogen, and phosphorus in saltwater marshes of Lavaca Bay, Texas. Final report.** Armstrong, N.E.; Hinson, M.O. Jr.; Collins, J.H.; Fruh, E.G. (Texas Univ., Austin (USA). Center for Research in Water Resources). 24 Jan 1975. 86p. Univ. of Texas at Austin, Center for Research in Water Resources, 10100 Burnet Road, Austin, TX 78758.

Both laboratory and field tests were conducted. Special sediment slurry uptake studies were performed for the purpose of developing Freundlich-like isotherms relating sediment concentrations of C, N, P to the equilibrium concentrations in water and to show the effects of sediment composition, salinity, and temperature on uptake. The flux of N and P into and out of sediment were studied in fixed-bed systems by continuously adding various amounts of N and P to these systems and following uptake in the sediments until equilibrium conditions were established, then stopping the additions and following the release of nutrients from the sediments. Mass balances were made for C, N, and P added in spiked and non-spiked Bay water, and productivity measurements were taken to determine the stimulatory effects of these nutrient additions. The field studies involved the collection of hydraulic and nutrient data at several stations in a bayou off Swan Lake in Lavaca Bay to determine net nutrient transport and exchange from and in the saltwater marshes. Mathematical models describing the sediment uptake of C, N, and P as a function of the mass transfer coefficient and the difference between equilibrium and ambient nutrient concentrations were developed.

30381 **(CRWR—129-Vol.2) Exchange of carbon, nitrogen and phosphorus in Lavaca Bay, Texas marshes. Volume II. The role of plants in nutrient exchange in the Lavaca Bay brackish marsh system. Final report.** Dawson, A.J.; Armstrong, N.E. (Texas Univ., Austin (USA). Center for Research in Water Resources). 31 Aug 1975. 126p. Univ. of Texas at Austin, Center for Research in Water Resources, 10100 Burnet Road, Austin, TX 78758.

The role of plants in nutrient exchange in the Lavaca Bay saltmarsh was studied. The rate of nutrient exchange, the comparative magnitude of the contributions of the various components of the marsh system to the exchange, and the effects of summer drying periods were studied. The rates of nutrient exchange varied with water level and were influenced by the effect of previous water levels on the productivity of the system. Algal mat communities released more phosphorus and nitrogen than did marsh grass communities but released less carbon. The release of nutrients from the system is attributed primarily to the products of decomposition. The sediments are an important source of nitrogen and phosphorus and serve as the primary site for nitrification processes. Periods of drying cause an abnormally high nutrient release when flows initially reinundate the area. The high productivity of the saltmarsh enables the marsh to export nitrogen, phosphorus, and carbon to the estuary.

30382 **(CRWR—147-Vol.1) Exchange of carbon, nitrogen, and phosphorus in Lavaca Bay, Texas marshes. Volume I. The role of sediments in nutrient exchange in the Lavaca Bay brackish marsh system. Final report.** Armstrong, N.E.; Brown, B.A. (Texas Univ., Austin (USA). Center for Research in Water Resources). 31 Dec 1976. 84p. (EHE—77-01-Vol.1). Univ. of Texas at Austin, Center for Research in Water Resources, 10100 Burnet Road, Austin, TX 78758.

The purpose was to determine the rates of release and uptake of nitrogen and phosphorus by sediments of the Lavaca Bay brackish marsh system and the effects of temperature and salinity on these rates. Fixed-bed reactors containing cores of marsh sediment were collected and operated as completely-mixed, flow-through reactors. Rates of release and uptake of nutrients were determined under varied temperature and salinity conditions.

30383 **(CRWR—153) Exchange rates for carbon, nitrogen, and phosphorus in the Colorado River delta marshes. Final report.** Armstrong, N.E.; Gordon, V.N. (Texas Univ., Austin (USA). Center for Research in Water Resources). 31 Aug 1977. 41p. Univ. of Texas, Center for Research in Water Resources, 10100 Burnett Road, Austin, TX 78758.

This study was undertaken to determine nutrient exchange rates from the marshes in the Colorado River delta to adjacent waters. Portions of the marshes were collected based on the representation of major plant types in this system. The samples for the plexiglass reactors were taken in the field with these reactors and returned intact ready for experimentation to the laboratory. The laboratory studies consisted of placing these reactors under controlled light and temperature conditions to simulate seasonal conditions in the field, imposing a diurnal tidal regime on the reactors, and measuring nutrient concentrations in the influent and effluent of the reactors. Based on the difference between mass and flow of each nutrient into and out of the reactors, an exchange rate was calculated in units of kg ha^{-1} d^{-1} for each reactor. Based on the major plant types contained in each reactor, the data for each reactor were grouped by major plant type and described. Seasonal changes in exchange rates were plotted and discussed. The exchange rates for carbon, nitrogen, and phosphorus for the major plant types were found to be very similar to exchange rates measured previously for similar plant types in Lavaca, Nueces, and San Antonio Bays and the Trinity River delta. Biological activity appeared to dominate the processes which affected concentrations of carbon, nitrogen, and phosphorus. Attached algae appeared to dominate the macrophytes affecting changes in nutrient concentrations; however, it was not possible to measure the release of phosphorus by the macrophytes alone and to determine their contribution to the exchange rates.

30384 **Transport of organic carbon to the oceans by rivers of North America: a synthesis of existing data.** Mullholland, P.J.; Watts, J.A. (Oak Ridge National Laboratory, Oak Ridge (USA). Environmental science division). *Tellus;* **34**: No. 2, 176-186(Apr 1982).

Transport of organic carbon in rivers of North America to the oceans was assessed by compiling and analyzing data from 82 North American rivers draining 60 per cent of Canada and the United States. These data were collected by the U.S. Geological Survey and the Water Resources Branch of Canada's Inland Waters Directorate. Mean annual concentrations of total organic carbon showed considerably less variation than did annual specific export ($gC\ m^{-2}\ yr^{-1}$). Regional variation in annual specific export of total organic carbon was attributed primarily to differences in annual runoff. Transport of total organic carbon to coastal regions by North American rivers totalled about $35 \times 10^{12} +- 5 \times 10^{12}\ gC\ yr^{-1}$ in 1979 and 1978. The total organic carbon flux to the oceans associated with the long-term average annual flow in North American rivers was computed to be about $40 \times 10^{12}\ gC\ yr^{-1}$, slightly larger than that in 1977 and 1978 because of the lower-than-average runoff in some regions those years.

30385 **Interelement relationship in abyssal Pacific ferromanganese nodules and associated pelagic sediments.** Li, Y.H. (Lamont-Doherty Geological Observatory, Palisades, NY). *Geochimica et Cosmochimica Acta;* **46**: 1053-1060(1982).

By R-mode factor analysis and enrichment factor calculations, most of the elements in abyssal ferromanganese nodules and associated pelagic sediments (excluding common authigenic minerals like apatite, barite, opal and carbonates) are found to be preferentially concentrated in one of the following three major phases: aluminosilicates (e.g., Al, Si, Sc, Ga, Cr, Be, Na, K, Rb and Cs), Fe-oxides (e.g., Fe, P, S, V, Se, Te, As, B, Sn, U, Hg, Pb, Ti, Ge, Y, Zr, Nb, Pd, In, rare-earths, Hf, Th, Pa, Pu, Am, Ru and Bi), and Mn-oxides (e.g., Mn, Tl, Ag, Cd, Mg, Ca, Ba, Ra, Co, Ni, Cu, Zn, Mo, Sb and probably W). The specific association of elements with these three phases can be explained by the difference in chemical forms of elements in seawater and by fundamental differences in physicochemical properties (e.g., the pH of zero point of charge and dielectric constant) of these three phases.

30386 **Dissolved humic materials: photodegradation, sediment effects, and reactivity with phosphate and calcium carbonate precipitation.** Stewart, A.J. (Oak Ridge National Lab., TN); Wetzel, R.G. *Archiv fuer Hydrobiologie;* **92**: No. 3, 265-286(Oct 1981). Contract AC02-76EV01599.

Dissolved humic materials (DHM) are often important constituents of the dissolved organic carbon (DOC) pool in lakes, but little is known about environmental factors that regulate DHM quality and quantity, or of the ecological importance of DHM in pelagial environments. Consequently, a number of experiments were undertaken to determine the relative importance of sediment/pH and of photolysis in regulating the quality and quantity of DHM in a small, hardwater lake. In addition, since DHM may affect pelagial primary producers by interacting with reactive nutrients, researchers examined certain relationships between DHM and orthophosphate, and between DHM and the process of $CaCO_3$ precipitation and phosphate coprecipitation. Sediment/pH conditions markedly influenced the spectral characteristics and apparent molecular weight spectra of DHM. Field and laboratory data indicated that organic-rich sediment selectively absorbs DHM of high apparent molecular weight leaching from scenescing littoral vegetation during rain events, and slowly releases DHM of lower apparent molecular weight between rain events. Sunlight or high-intensity uv light was sufficient to cause rapid (< 300 min) alteration in the spectral characteristics of DHM, and solar radiation is likely important in seasonal regulation of DHM quality in shallow waters and in the upper photic zone in pelagial areas. Low concentrations (< 2 mg l^{-1}) of fulvic material were found to be potent inhibitors of the $CaCO_3$ precipitation process under natural conditions, but did not significantly alter short-term (0 to 3 days) rates of ^{14}C assimilation by natural algal assemblages. Binding of orthophosphate to DHM could not be demonstrated under conditions similar to those in the epilimnion of the study site, but may be an important regulator of phosphate in systems of lower alkalinity.

30387 **Ocean chemistry and atmospheric CO_2.** Baes, C.F. Jr. (Oak Ridge Associated Univ., TN). *American Chemical Society, Division of Petroleum Chemistry, Preprints;* **26**: No. 4, 978-986(Sep 1981). (CONF-810813—(Vol.2)). Contract AC05-76OR00033.

From National American Chemical Society summer meeting; New York, NY, USA (23 Aug 1981).

Deep circulation of the ocean is sluggish, and only the upper 75 m, as a result of wind stress, are well mixed. This layer is affected by and responds fairly quickly (ca a y) to changes in the atmospheric concentration of CO_2. How this interaction with the atmosphere is affected by circulation, by calcium carbonate dissolution and precipitation, and by the biological process of photosynthesis and decay, is considered. 4 figures.

30388 **Longterm dissolved and particulate alkaline phosphatase activity in a hardwater lake in relation to lake stability and phosphorus enrichments.** Wetzel, R.G. (Michigan State Univ., Hickory Corners). *Verhandlungen - Internationale Vereinigung fuer Theoretische und Angewandte Limnologie;* **21**: 369-381(Jul 1981). Contract AC02-76EV01599.

Particulate and dissolved alkaline phosphatase activities (PO_4-ase) were determined biweekly at 1 m depth intervals for over 6 years in an oligotrophic, hardwater lake of southwestern Michigan. PO_4-ase activities were low during autumnal circulation and winter stratification. PO_4-ase of the spring period varied markedly from year to year, and was inversely related to lake stability and the extent of spring circulation. Birgean work and Schmidt stability computations demonstrated the acute effects of restricted circulation periods in certain years on subsequent metabolic activities in the epilimnion. Extremely high PO_4-ase occurred in the phytoplankton during spring and summer periods of years of temporary spring meromixis or partial circulation. During mid-summer stratification, high PO_4-ase coincided with periods of reduced productivity in the epilimnion, reduced diatom development, and massive epilimnetic decalcification and co-precipitation of P with $CaCO_3$. During mid-summer a non-N_2-fixing cyanophyte and chlorophyte flora commonly developed in the metalimnion. Experiments with epi (2 m) and metalimnetic (6 m) phytoplankton were conducted for an annual period. Reductions in PO_4-ase and enhancement of C-uptake and chlorophyll concentrations occurred following enrichment with inorganic P, and to a lesser extent with organic P. Epilimnetic phytoplankton responded more strongly to P than did metalimnetic phytoplankton, and P limitation was most acute in early and mid-summer.

30389 **Role of lake and reservoir sediments as sinks in the perturbed global carbon cycle.** Mulholland, P.J.; Elwood, J.W. (Oak Ridge National Laboratory, Oak Ridge, Tennesse (USA). Environmental sciences division). *Tellus;* **34**: No. 5, 490-499([nd]).

We estimate that recent increases in organic carbon accumulation in the sediments of lakes and reservoirs amount to about $0.02 \times 10^{15}\ gC\ yr^{-1}$ and $0.2 \times 10^{15}\ gC\ yr^{-1}$, respectively. The reservoir accumulation represents a small but significant fraction of the carbon missing in current global budgets.

5203 Radioactive Materials Monitoring And Transport

REFER ALSO TO CITATION(S) 29121, 29122, 29123, 29156, 29169, 29170, 29220, 29241, 29248, 29249, 30362, 30363, 30467, 30590, 30593

30390 (LA—9479-PR, pp 126-127) **Development of a simplified model to predict runoff, sediment yield, and contaminant transport in Mortandad Canyon.** Lane, L.J.; Hakonson, T.E.; White, G.C. Oct 1982. NTIS, PC A08/MF A01.

In Los Alamos Life Sciences Division's biomedical and environmental research programs. Progress report, January-December 1981.

Described is a model to predict sediment transport, by particle size classes, in alluvial streams with noncohesive sediments. Procedures are developed to predict the transport rate of contaminants traveling in association with sediment particles. Runoff, sediment, and contaminant rates are integrated over a given period of runoff to estimate water, sediment, and contaminant yields. An example

application is for plutonium transport in an effluent-receiving canyon at the Los Alamos National Laboratory. (DLS)

30391 **(USGS-OFR—82-3) Hydrogeology of the Dakota Group aquifer with emphasis on the radium-226 content of its contained ground water, Canon City Embayment, Fremont and Pueblo Counties, Colorado.** Vinckier, T.A. (Colorado Geological Survey, Denver (USA)). 1982. 173p. Geological Survey Open File Service, Box 25425, Denver Federal Center, Denver, CO 80225.

Thesis. Submitted to Univ. of Colorado, Boulder.

The Dakota Group aquifer of the Canon City embayment comprises two primary water-bearing units, the Lytle Sandstone Member at the base and the Dakota Sandstone at the top, separated by the semiconfining, arenaceous Glencairn Shale Member. The ground water in this area probably represents a mixture of some or all of the following genetic types: (1) ground water connate to the Dakota Group; (2) ground water, connate or otherwise, entering the aquifer as leakage from adjacent semiconfining strata; (3) deeply circulated meteoric ground water; and (4) hydrothermal fluids (magmatic or metamorphic ground water) purged from the crystalline basement complex underlying the embayment. The contents of the radium-226 in ground water from 117 wells completed in part or all of the Dakota Group were determined by the dissolved radon-222 emanation method. Sixty-seven percent of the ground water samples have radium-226 activities greater than 5.0 picocuries per liter of water (5.0 pCi/1), the recommended maximum permissible concentration of radium-226 in drinking water established by the Environmental Protection Agency in 1973. Inspection of gamma-ray logs of about 20 wells revealed the presence of moderate to extremely high gamma radiation in strata of the Dakota Group, the Morrison Formation, the Fountain Formation, and in the crystalline basement rocks. High levels of radium-226 in drinking water supplies pose potentially serious health hazards to the users. Owners of wells producing such water supplies are advised to (1) install, at the homesite, ion exchange (filtering units) capable of removing $^{226}Ra^{2+}$ ions and other aqueous radium species from the water or (2) effectively case out those stratigraphic intervals in the bore hole showing high gamma radiation preventing possible radium-rich ground water within these intervals from entering the well.

5204 Thermal Effluents Monitoring And Transport

30392 **(CRWR—80) Before-and-after studies of the effects of a power-plant installation on Lake LBJ: a numerical temperature model for Lake LBJ. Interim technical report No. 1.** Park, G.G.; Schmidt, P.S. (Texas Univ., Austin (USA). Center for Research in Water Resources). Dec 1971. 187p. Univ. of Texas at Austin, Center for Research in Water Resources, 10100 Burnet Road, Austin, TX 78758.

A one-dimensional mathematical model for predicting the distribution of thermal energy in a deep, stratified reservoir is developed and applied to Lake LBJ. The model takes into account heat transfer through the air-water interface, advection into and out of the reservoir, and advection and diffusion in the vertical direction within the reservoir. A comparison of predicted and observed temperatures profiles shows good agreement. To predict the physical effects of the thermal discharge from a proposed power plant on a region of Lake LBJ, the model has been modified to account for temperature gradients in the longitudinal direction in addition to the vertical. Although there are limitations to the use of this two-dimensional model, it is a good starting point for more refined analyses of the physical effects of a thermal discharge on a stratified reservoir.

30393 **(CRWR—149) Before-and-after studies on the effects of a power-plant installation on Lake Lyndon B. Johnson. Before studies, Volume III. Temperature modeling. Final report to the Lower Colorado River Authority.** Fruh, E.G.; Maguire, B. Jr.; Schmidt, P.S. (Texas Univ., Austin (USA). Center for Research in Water Resources). Jun 1975. 102p. Univ. of Texas, Center for Research in Water Resources, 10100 Burnett Road, Austin, TX 78758.

The overall objective of this project is to determine the influence of Lower Colorado River Authority (LCRA) power plant operations on the Lake LBJ ecosystem. Phase I of this effort focussed on the behavior of the reservoir and its ecosystem before power plant operations began. A series of computer model studies carried out to predict thermal and hydrodynamic effects of the plant is summarized. A one-dimensional stratification model was developed to analyze the normal annual temperature variations in the reservoir without an artificial thermal input. Diffusion was found to be the dominant heat transport mechanism in the hypolimnion, while surface heat exchange and wind-induced mixing dominate in the epilimnion. Advection was not found to be particularly significant. The stratification model was two-dimensionalized to permit gradients in the horizontal plane, and the two-dimensional model was used to predict cooling rates for the far-field region of the thermal discharge. From the far-field studies, it was predicted that the discharge bay region of Lake LBJ will remain thermally stratified during most of the year, with a uniform surface layer six to twelve feet deep. During the warm months temperatures at the mouth of the bay may still be several degrees above ambient when the plant is operating at full load. A new-field model was used to attempt a prediction of thermal plume behavior in the region near the discharge channel. Despite several problems, some qualitative conclusions were obtained from the study; the model predicted that the plume would rapidly stabilize in depth, and that because buoyancy would inhibit vertical entrainment, the temperature gradient below the heated surface layer should be quite sharp.

30394 **(CRWR—150) Before-and-after studies on the effects of a power-plant installation on Lake Lyndon B. Johnson: thermal and hydrodynamic behavior of a low-Froude-number power-plant discharge - analytical modeling and field verification. Interim Report No. 7.** Fix, R.L.; Schmidt, P.S. (Texas Univ., Austin (USA). Center for Research in Water Resources). Jun 1977. 321p. Univ. of Texas, Center for Research in Water Resources, 10100 Burnett Road, Austin, TX 78758.

This paper discusses the field investigations and analytical simulation of the thermal discharge from the Ferguson Power Plant into Horseshoe Bay on Lake Lyndon B. Johnson. A total of 14 field studies were conducted from July 1975 through April 1976 to determine the thermal and hydrodynamic effects of the thermal discharge on the cooling bay. The plume field investigations identified the effects of wind velocity, power-plant generation level, cooling-water flow rate and the variations due to diurnal and seasonal cycles. The outfall densimetric Froude number for the Horseshoe Bay discharge is approximately unity, thus, buoyancy forces cause the plume to float on top of the underlying ambient water as it moves through the cooling bay. As a result the field studies indicated that the cooling rate and development of the plume is greatly affected by wind velocity and land boundaries. An analytical plume model was developed according to an integral technique in which the temperature and velocity distributions for both the lateral and vertical directions were assumed to be known. The results of the simulated plume studies indicate that the model accurately depicts the plume characteristics for those field conditions where land boundaries do not dominate the flow. A procedure is proposed which would include the effects of land boundaries in the analytical simulations.

30395 **(SFB—80/ET/205) Turbulent lateral mixing in raceway flows.** Webel, G. (Karlsruhe Univ. (T.H.) (Germany, F.R.). Sonderforschungsbereich Ausbreitungs- und Transportvorgaenge in Stroemungen). Apr 1982. 137p. (In German). Available from Fachinformationszentrum Energie, Physik, Mathematik, Karlsruhe (Germany, F.R.).

The results of the concentration measurements performed to determine the dependence on the parameters of the main flow, namely ratio of width to depth, Reynolds number, Froude number and floor roughness of the lateral mixing coefficient show that in the cases relevant for practical application the influence of the width/depth ratio as well as of the Froude number is small. The value of the lateral mixing coefficient is mainly determined by the floor roughness of the waste heat and waste water piping.

30396 **Structuring of a predator population through temperature-mediated effects on prey availability.** Adams, S.M.; McLean, R.B.; Huffman, M.M. (Oak Ridge National Lab., TN). *Canadian Journal of Fisheries and Aquatic Science;* 39: No. 8, 1175-1184(1982). Contract W-7405-ENG-26.

Temperature can control the structure of a predator population by regulating the abundance and size availability of prey. Relatively small differences in winter temperatures between years can have a major influence on largemouth bass (Micropterus salmoides) population structure because of the threshold relationship between temperature and the lower lethal limits of shad. The relationship between prey availability and predator growth and mortality was established through field measurements of consumed energy. Growth and consumption of largemouth bass in Watts Bar Reservoir, Tennessee, was lower in 1979 than in 1980 as a result of lower winter water temperature in 1979, which reduced the abundance and availability of adequate-sized prey. Depending on the severity of the winter, bass that do not attain 25 +- 5 cm by the end of their first growing season do not survive to annulus I formation because of the unavailability of appropriate-sized prey in the spring and the inability of small bass to store sufficient energy reserves. Selective mortality favoring survival of larger individuals in an age-class is operating in the Watts Bar largemouth bass population. This has significant implications for predator growth in ecosystems that experience large seasonal fluctuations in prey availability.

5205 Site Resource And Use Studies

REFER ALSO TO CITATION(S) 29250, 29251, 29252, 30375, 30397

5206 Regulations

REFER ALSO TO CITATION(S) 29751

53 ENVIRONMENTAL-SOCIAL ASPECTS OF ENERGY TECHNOLOGIES

REFER ALSO TO CITATION(S) 29751

5301 Social And Economic Studies

REFER ALSO TO CITATION(S) 30398

5302 Assessment Of Energy Technologies

REFER ALSO TO CITATION(S) 30526

5303 Environmental Impact Statements

30397 **(INT-FES—83-19) Proposed Navajo Railroad Project. Final environmental impact statement.** (Bureau of Indian Affairs, Washington, DC (USA)). 25 Feb 1983. 130p. Dept. of the Interior, Bureau of Indian Affairs, Washington, DC 20245.

The Consolidation Coal Co. proposes to construct and operate a railroad from a point on the San Juan River, approximately 8 miles east of Shiprock, New Mexico, south to a junction with the Atchison, Topeka and Santa Fe (AT and SF) Railways main east-west line. The proposal includes a spur line into Consolidation Coal Co.'s Navajo Coal Lease at Burnham, New Mexico. The purpose of the proposed project is to provide a means of transporting coal from the Consolidation Coal Co.'s Burnham Mine to potential markets in the southwestern United States. At maximum projected shipment levels the railroad would haul 9.7 million tons of coal from the Burnham Mine annually. The preferred alternative would extend south from Burnham to the AT and SF Railway's industrial spur west of Gallup, New Mexico. An alternative to the Navajo Railroad southern alignment (Burnham Mine south to Gallup) is the Star Lake Railroad connection. The Star Lake Railroad connection would involve construction of approximately 18 miles of railroad from the Burnham Mine east to a point on the Navajo Indian Reservation line where it would join AT and SF's proposed Star Lake Railroad. Primary impacts from construction and operation of the proposed Navajo Railroad project will be on the area's socioeconomics, Navajo socioculture, land use, archeology, localized visual effects and noise. Minor impacts are anticipated on geology, terrestrial ecology, aquatic ecology, water resources, air quality and climatology. Socioeconomic impacts will be largely positive, resulting in new job opportunities, and additional royalty revenues for state, local and Navajo governments. Mitigating measures are proposed to minimize adverse impacts. Six alternatives are considered and analyzed.

30398 **(NP—3901807) Final Environmental Impact Statement on oil and gas leasing in the National Petroleum Reserve in Alaska.** (Bureau of Land Management, Anchorage, AK (USA)). Feb 1983. 292p. Alaska State Office, Public Room, 701 C Street, Box 13, Anchorage, Alaska 99513.

This Final Environmental Impact Statement (Final EIS) is the compliance document required prior to completing decisions implementing the National Petroleum Reserve in Alaska (NPR-A) competitive oil and gas leasing program. Consideration is given this appropriate conditions for inclusion in future oil and gas leasing sales exclusive of acreage previously leased in January and May 1982 under a Congressional National Environmental Policy Act (NEPA) compliance exemption. The impact analyses within this Final EIS are based on hypothetical and/or analogous examples of the types of industrial activities which may follow additional leasing in NPR-A. Consistent with aiding a decision-making process, this Final EIS places major emphasis on key resources and issues most at risk of being significantly affected by any industrial activity following the issuance of additional leases. These key resources and issues were identified in this Final EIS by comparison to three risk factors: vulnerability of the resource/issue; sensitivity of the resource/issue to industrial activities; and the nature of mitigation. Based on these risk factors and public comments received during the EIS scoping and Draft EIS processes, including extensive public meetings in Anchorage, Fairbanks, and in villages on or adjacent to NPR-A, this Final EIS concentrated its analyses on the following resources: Caribon, grizzly bear, polar bear, white-fronted geese, black brant, peregrine falcon and other cliff-nesting reptors, and the fisheries. Issues enphasized and recreation, primitiveness, sociocultured and subsistence issues.

55 BIOMEDICAL SCIENCES, BASIC STUDIES

5501 Behavioral Biology

REFER ALSO TO CITATION(S) 30461, 30565

30399 **(DOE/SR/01072—4) Initial historic overview of the Savannah River Plant, Aiken and Barnwell Counties, South Carolina.** Brooks, R.D. (South Carolina Univ., Columbia (USA). Inst. of Archeology and Anthropology). 1980. Contract AS09-78SR01072. 129p. NTIS, PC A07/MF A01. Order Number DE83010304.

Portions are illegible in microfiche products.

This historic overview begins with the initial European contacts in the southeastern United States. Specific information about the Savannah River Plant site is not available until circa 1750 when the first settlement of the area began. The overview becomes more specific as it advances chronologically toward the present. (ACR)

30400 (LA—9479-PR, pp 140) **Natural regeneration of ponderosa pine as related to land use and fire history of the Pajarito Plateau.** Potter, L.D.; Foxx, T.S.; Barnes, F.J. Oct 1982. NTIS, PC A08/MF A01.

In Los Alamos Life Sciences Division's biomedical and environmental research programs. Progress report, January-December 1981.

In 1977, a major wildfire (La Mesa fire) burned over land under control of the National Park Service, United States Forest Service, and Department of Energy. Each of these agencies, by virture of their mandates, have a different concept as how to maintain

the burned land. A study was designed to look at natural regeneration of pine after fire as related to the varius types of land management and restoration processes.

5502 Biochemistry

REFER ALSO TO CITATION(S) 29986, 30087, 30088, 30092, 30435, 30438, 30444, 30448, 30449, 30450, 30451, 30524, 30540, 30557, 30569, 30570, 30571, 30573

30401 (DOE/EV/02101—47) Synthesis of DNA containing uracil during bacteriophage infection of Bacillus subtilis. Final report (12th year). Price, A.R. (Michigan Univ., Ann Arbor (USA). Dept. of Biological Chemistry). 1 Feb 1983. Contract AC02-76EV02101. 26p. (COO—2101-47). NTIS, PC A03/MF A01. Order Number DE83009701.

The mode of synthesis of enzymes and nucleotides induced by bacteriophages PBS1 and PBS2 has been studied to understand how these phages can make uracil-containing DNA in a cell which normally makes thymine-containing Bacillus subtilis DNA.

30402 (LA—9479-PR, pp 2-3) Resolution improvements. Holm, D.M.; Jett, J.H.; Martin, J.C.; Wilder, M.E.; Bartholdi, M.F.; Cram, L.S.; Hiebert, R.D. Oct 1982. NTIS, PC A08/MF A01.

In Los Alamos Life Sciences Division's biomedical and environmental research programs. Progress report, January-December 1981.

Improved DNA resolution is particularly important for chromosome analysis where it is desirable to completely resolve different chromosome types. A systematic analysis of all factors that contribute to DNA resolution measurements is underway with work concentrated on instrumentation contributions and centered on the electronics, photon statistics, and laser light fluctuations. A complete analysis of the most important factors contributing to the broadening of the coefficient of variation (cv) is important for achieving the ultimate in small CVs since it will not be possible to resolve the individual chromosomes by DNA analysis in the human karyotype unless the instrumentation contribution to CV is reduced to 0.5%. (DLS)

30403 (LA—9479-PR, pp 31-35) Histone variants and histone modifications associated with constitutive heterochromatin. Gurley, L.R.; Halleck, M.S.; Valdez, J.G. Oct 1982. NTIS, PC A08/MF A01.

In Los Alamos Life Sciences Division's biomedical and environmental research programs. Progress report, January-December 1981.

Histone metabolism studies have led to the proposal that certain histone modifications (Phosphorylation, acetylation, and amino acid variation) are involved in various stages of chromatin condensation. Results described provide further support for one aspect of this concept: the involvement of unacetylated arginine-rich histones and the involvement of a specific H2A variant in condensed constitutive heterochromatin structure. The extent of histone modifications as examined in cultured cell lines of the deer mouse (peromyscus) containing differing amounts of highly condensed, constitutive heterochromatin. Histone H1 phosphorylation was the same in various cell lines, but the phosphorylation of histone H2A was higher in the greater-heterochromatin-containing cells. (DLS)

30404 (LA—9479-PR, pp 38-41) Synthesis of histone $H1^{0}$ in synchronized Chinese hamster cells. D'Anna, J.A.; Gurley, L.R.; Tobey, R.A.; Sebring, R.J.; Valdez, J.G.; Kissane, R.J.; Tesmer, J. Oct 1982. NTIS, PC A08/MF A01.

In Los Alamos Life Sciences Division's biomedical and environmental research programs. Progress report, January-December 1981.

Treatment of synchronous CHO cells with butyrate causes an increase in the proportion of G_1 cells and an increase in cellular content of histone $H1^{0}$. These observations suggest that $H1^{0}$ may play a functional role in the control of DNA synthesis, in condensation of chromatin, in the appearance of a G_1 phase, and in cellular regulation by glucocorticoids. Data further suggest the synthesis of $H1^{0}$ is uncoupled from that of DNA, that newly synthesized $H1^{0}$ is not simply a packaging agent for DNA, and $H1^{0}$ may alter chromatin structure and expression during the G_1 phase. (DLS)

30405 (LA—9479-PR, pp 78-79) Assay for collagenase using peroxidase-labeled collagen as a substrate. Tate, E.H. Oct 1982. NTIS, PC A08/MF A01.

In Los Alamos Life Sciences Division's biomedical and environmental research programs. Progress report, January-December 1981.

The chronic lung diseases, fibrosis and emphysema, are characterized by abnormalities in the biosynthesis and degradation of collagen and elastin, the major connective tissue components in the lung. Abnormal collagen deposition is indicative of fibrosis, while abnormal destruction of elastin characterizes emphysema. Researchers are currently conducting studies to determine what biochemical changes occur in rat lungs after the animals are exposed to various doses of raw and spent shale oil particulates by inhalation. Determinations of lung collagen and elastin contents and the activity of several degradative enzymes found in fluid lavaged from rat lungs are being made on treated and control rats. Measurement of the degradative enzyme activities necessitated the development of enzyme assays. This report describes our newly developed assay for collagenase using horseradish peroxidase (HRP) conjugated collagen as the substrate.

30406 (LA—9479-PR, pp 120-121) National stable isotopes resource. Whaley, T.W. Oct 1982. NTIS, PC A08/MF A01.

In Los Alamos Life Sciences Division's biomedical and environmental research programs. Progress report, January-December 1981.

A summary of the investigators who were provided with labeled compounds during the past year is given.

30407 Theoretical calculations of kinetics of the radical pair P/sup E/ state in bacterial photosynthesis. Tang, J.; Norris, J.R. (Argonne National Lab., IL). *Chemical Physics Letters;* **92**: No. 2, 136-140(15 Oct 1982). Contract W-31-109-ENG-38.

Calculations of the time evolution of the population in the transient radical pair P/sup F/ state and the magnetic field dependence of the effective decay time are presented. A general treatment is proposed to include (1) unequal decay rates k/sub T/ and k/sub S/ for the triplet and the singlet, (2) the anisotropic electron-electron dipolar interaction and (3) the multiple nuclear hyperfine interaction. It is found that the dipolar interaction and the exchange interaction have a strong impact on the field dependence of the effective decay time. In addition, the time evolution of the P/sup F/ population is found to be quasi-exponential for k/sub T/ > k/sub S/, and the effective decay rate is determined much more by the singlet decay rate than the triplet decay rate as long as dominant spin-spin interactions are present. The decay curve becomes non-exponential as k/sub S/ becomes larger than k/sub T/.

30408 Free radicals and tissue damage produced by exercise. Davies, K.J.A.; Quintanilha, A.T.; Brooks, G.A; Packer, L. (California Univ., Berkeley). *Biochemical and Biophysical Research Communications;* **107**: No. 4, 1198-1205(31 Aug 1982).

Reported is a two- to three-fold increase in free radical ($R^{\bullet}$) concentrations of muscle and liver following exercise to exhaustion. Exhaustive exercise also resulted in decreased mitochondrial respiratory control, loss of sarcoplasmic reticulum (SR) and endoplasmic reticulum (ER) integrity, and increased levels of lipid peroxidation products. Free radical concentrations, lipid peroxidation, and SR, ER, and mitochondrial damage were similar in exercise exhausted control animals and non-exercised vitamin E deficient animals, suggesting the possibility of a common $R^{\bullet}$ dependent damage process. In agreement with previous work showing that exercise endurance capacity is largely determined by the functional mitochondrial content of muscle, vitamin E deficient animals endurance was 40% lower than that of controls. The results suggest that $R^{\bullet}$ induced damage may provide a stimulus to the mitochondrial biogenesis which results from endurance training.

30409 Inactivation of Rhodospirillum rubrum ribulose bisphosphate carboxylase/oxygenase by the affinity label 2-N-chloroamino-2-deoxypentitol 1,5-bisphosphate. Christeller, J.T.; Hartman, F.C. (Oak Ridge National Lab., TN). *FEBS (Federation of European Biochemical Societies) Letters;* **142**: No. 1, 162-166(Jun 1982). Contract W-7405-ENG-26.

Ribulose-P_2 carboxylase/oxygenase (EC 7.1.1.39) catalyzes the carboxylation and oxygenation in the initial steps of photosynthetic CO_2 fixation and photorespiration, respectively. As a probe of the region of the active site where the gaseous substrate (O_2 or CO_2) and the divalent metal ion bind, we have chosen a compound, Cl-aminopentitol-P_2, with a reactive moiety at the position corresponding to C-2 of ribulose-P_2 at which both carboxylation and oxygenation occur. The reagent is an equimolar mixture of the arabino-and ribo-epimers, as it is prepared from amino-pentitol-P_2 obtained by reductive amination of D-ribulose-P_2. Halo-amines, as both oxidizing and halogenating reagents, have a wide potential for modifying amino acid residues. The general chemical properties of halo-amines and the suggestion of an essential tyrosyl residue in ribulose-P_2 carboxylase based on inactivation by tetranitromethane, the evaluation of Cl-aminopentitol-P_2 as an affinity label seemed appropriate. Here, we show that the new reagent selectively oxidizes a methionyl residue in the active-site region of the Rhodospirillum rubrum carboxylase.

30410 Amplification of the uvrA gene product of Escherichia coli to 7% of cellular protein by linkage to the p/sub L/ promoter of pKC30. Yoakum, G.H. (National Cancer Inst., Bethesda, MD); Yeung, A.T.; Mattes, W.B.; Grossman, L. *Proceedings of the National Academy of Sciences of the United States of America;* **79**: 1766-1770(Mar 1982).

Researchers have constructed a hybrid pKC30-uvrA plasmid (pGHY5003) in which transcription of the uvrA gene can be induced under p/sub L/ control to amplify the uvrA gene product to 7% of cellular protein. To construct pGHY5003, researchers developed a genetic selection using the basal level of expression (30°C) from p/sub L/ in thermosensitive cI857 lysogens to isolate appropriately tailored repair genes inserted at the Hpa I site of pKC30 from recombinant DNA mixtures with a variety of products. In addition, a post-uv-irradiation radiolabeling method was adapted to screen inserts for temperature-inducible polypeptide synthesis directed by transcription under p/sub L/ control rapidly. This should prove generally useful for isolating genes inserted at the Hpa I site of plasmid pKC30 with the following characteristics: (1) genetically functional hybrid plasmids selected from a large population of exonucleolytically tailored fragments ligated into Hpa I of pKC30 and (2) production of high-level amplification for the gene product of interest by screening for post-uv-irradiation temperature inducibility of polypeptides synthesized from hybrid plasmids. The level of amplification obtained for the uvrA gene product from pGHY5003 is approximately 10,000-fold higher than estimates of the level of uvrA protein in logarithmic phase Escherichia coli.

30411 Betaine synthesis and accumulation in barley during field water-stress. Hitz, W.D.; Ladyman, J.A.R.; Hanson, A.D. (Michigan State Univ., East Lansing). *Crop Science;* **22**: No. 1, 47-54(Jan 1982). Contract AC02-76ER01338.

The timing and extent of betaine accumulation by mature leaves of barley (Hordeum vulgare L.) were followed in irrigated (I) and non-irrigated (N-I) plots under rain-shelters. In the N-I crop, leaf water potential (/sup psi/leaf) began to fall at the five-leaf stage, continued to drop steadily until maturity, and reached a minimum of about -35 bars. Betaine accumulation started in the N-I crop about a week after the decline in /sup psi/leaf began and continued until about 10 days post-anthesis. The maximum betaine concentration attained by N-I leaves (100 μmol/g dry wt) was three times that in I leaves. Betaine accumulation by upper leaves was due mainly to de novo synthesis in these leaves, because: (1) there was little ^{14}C-import into upper leaves when [^{14}C]betaine was applied to lower leaves, and (2) attached upper leaves of N-I plants rapidly converted supplied [^{14}C]ethanolamine to [^{14}C]betaine during the peak period of betaine accumulation. Phosphatidylcholine (PC) behaved as an intermediate in the conversion of [^{14}C]ethanolamine to betaine. The estimated peak metabolic cost of betaine biosynthesis via PC by stressed leaves (about 2 mg hexose/g dry wt/day) approached the cost of protein turnover in the same leaves (3 to 5 mg hexose/g dry wt/day) as estimated from [^3H]lysine incorporation. In N-I plants, cessation of betaine synthesis preceded the onset of senescence by several days, indicating that continuous betaine production is not mandatory for leaf function at lowered /sup psi/leaf. These field results are consistent with an adaptive value for betaine accumulation in barley during prolonged water stress. A search for genetic variation in betaine-accumulating potential in barley is now warranted.

30412 A simple method of eluting proteins from two-dimensional gels. Guevara, J. (Texas Medical Center, Houston); Chiocca, E.A.; Clayton, F.C.; von Eschenbach, A.C.; Edwards, J.J. *Clinical Chemistry (Winston-Salem, North Carolina);* **28**: No. 4, 756-758(1982).

Apo A-I lipoprotein was extracted from the appropriate pieces of two-dimensional gel patterns, by electrophoresis onto hydroxylapatite overlaying a slab of polyacrylamide sodium dodecyl sulfate gel. The extracted protein was then eluted from the hydroxylapatite by washing with increasing concentrations of phosphate buffer. The recovered protein was electrophoretically homogeneous. We believe that this method can be generally useful in the purification, for study, of proteins identified on two-dimensional gels as putative markers of disease.

30413 Sodium butyrate induced structural changes in HeLa cell chromatin. Reczek, P.R.; Weissman, D.; Huvos, P.E.; Fasman, G.D. (Brandeis Univ., Waltham, MA). *Biochemistry;* **21**: 993-1002(1982). Contract AC02-78EV04962.

Postsynthetic modifications of core histones by treatment of HeLa S3 cells with 5 mM sodium butyrate lead to alterations in the structure of high molecular weight chromatin. Whole chromatin from butyrate-treated cells, which results in highly acetylated core histones, has an ellipticity [θ]/sub 282.5/ of 3700 deg cm^2 dmol^{-1} (0.2 mM EDTA, pH 7.4) that is 1200 deg cm^2 dmol^{-1} less than chromatin from untreated HeLa cells, suggesting a more condensed structure. No difference in the circular dichroism spectra was observed in HI-stripped, high molecular weight chromatin obtained from control and butyrate-treated cells at low (0.2 mM EDTA, pH 7.4) ionic strength.Thermal denaturation profiles of high molecular weight chromatin were resolved into three transitions and exhibited a shifting of hyperchromicity from transition I to transition III, at a higher T/sub m/, with butyrate treatment of HeLa cells, further indicating a more compact structure. Thermal denaturation profiles of HI-stripped chromatin were not affected by butyrate treatment. Ionic strength studies in the range of 0-5 mM NaH_2PO_4, 0.2 mM EDTA, pH 7.4, of high molecular weight chromatin exhibited a decrease in [θ]/sub 282.5/ and a shifting of hyperchromicity from transition I to transition III with increasing ionic strength. Control high molecular weight chromatin was more sensitive to changes in ionic strength than its highly acetylated counterpart. These results suggest that acetylation of histones alone does not result in a change in histone-DNA interaction but other changes associated with butyrate treatment most probably cause a more condensed structure, of the fraction studied herein, which is mediated by HI or other materials removed during stripping in 0.35 M NaCl.

30414 Ecdysone metabolism in premolt land crabs (Gecarcinus lateralis). McCarthy, J.F. (Oak Ridge National Lab., TN). *General and Comparative Endocrinology;* **47**: 323-332(1982). Contract W-7405-ENG-26.

The metabolic fate of [^3H]ecdysone was examined in land crabs (Gecarcinus lateralis) in premolt stages D_1 (late)-D_2 and D_3 to elucidate changes in biochemical pathways and dynamics of ecdysteroid metabolism during proecdysis. In crabs of both premolt stages, 20-hydroxyecdysone was the principal metabolite (85 to 95% of the recovered radioactivity); further hydroxylation to 20,26-dihydroxyecdysone and formation of polar conjugates (primarily in the midgut gland) occurred to a limited extent. The rate of elimination of [^3H]20-hydroxyecdysone was slow in crabs of both premolt stages (k ~ 0.006 to 0.009 hr^{-1}; t/sub 1/2/ ~ 77 to 115 hr). Serum titers of 20-hydroxyecdysone (measured by radioimmunoassay) increased during stages D_0 to D_3 and maintained a maximum level of 100 ng/ml for a week (stage D_3-early D_4) before dropping rapidly to intermolt levels during the last day before ec-

dysis (stage D_3 to D_4). The rapid decrease in serum titers results from a 10-fold increase in the rate of elimination of serum ecdysteroids at about 24 to 48 hr before ecdysis. The titer of an apolar ecdysteroid, tentatively identified as ponasterone. A, increases rapidly during stages D_1 and D_2 to levels several-fold higher than the maximum titers of 20-hydroxyecdysone. Ponasterone A titers then decreased very rapidly during the last 3 days before ecdysis (stages D_3 and D_4).

30415 **Adenine nucleotide content of corn roots as affected by injury and subsequent washing.** Gronewald, J.W.; Hanson, J.B. (Univ. of Illinois, Urbana). *Plant Physiology;* **69**: 1252-1256(1982). Contract AC02-76EV00790.

The adenine nucleotide content of the 2-centimeter segments excised from tray-grown corn roots declines for the first hour after excision. Concomitant with the loss of adenine nucleotides is a decline in respiration and a leakage of K^+. With continued washing, these parameters partially or completely recover and increased phosphate influx develops. Increasing the wound effect by cutting 0.5-centimeter segments gives a more rapid and pronounced degradation of adenine nucleotides and slower recovery. Conversely, the mild injury caused by submerging intact roots induces less degradation and produces greater net adenine nucleotide synthesis during recovery; adding auxin to the washing medium produces a similar result. With all treatments, there is stabilization of energy charge at about 0.85. Brief submersion of rubbing of intact roots, as well as recutting washed and recovered root segments, will initiate the transient loss of adenine nucleotides but will not induce increased phosphate influx. It is suggested that the loss in adenine nucleotides may reflect homeostasis in energy charge via catabolism arising from membrane permeability changes.

30416 **Lipid composition of a plasma membrane enriched fraction of maize roots.** Gronewald, J.W.; Abou-Khalil, W.; Weber, E.J.; Hanson, J.B. (Univ. of Illinois, Urbana). *Phytochemistry;* **21**: No. 4, 859-862(1982). Contract AC02-76EV00790.

The lipid composition of a plasma membrane enriched fraction isolated from corn (Zea mays) roots was examined. On a wt basis, the lipid:protein ratio was 1.11. Phospholipids comprised 60% of total lipids with the major phospholipids being phosphatidylcholine (62%) and phosphatidylethanolamine (21%). Free sterol was the major neutral lipid. The sterol:phospholipid molar ratio was 0.31. The fatty acid composition of the membrane was predominantly linoleic (60%) and palmitic (30%).

30417 **Picosecond fluorescence kinetics and energy transfer in chloroplasts and algae.** Haehnel, W.; Nairn, J.A.; Reisberg, P.; Sauer, K. (Lawrence Berkeley Lab., CA). *Biochimica et Biophysica Acta;* **680**: 161-173(1982). Contract W-7405-ENG-48.

Single-photon timing with picosecond resolution is used to investigate the kinetics of the fluorescence emission of chlorophyll a in chloroplasts from spinach and pea and in the algae Chlorella pyrenoidosa and Chlamydomonas reinhardii. The fluorescence decay is best described by three exponential components in all species. At low light intensity and with open reaction centers of Photosystem II (F_0), researchers find lifetimes of approx. 100, 400 and 1100 ps for the three components. Closing the reaction centers by addition of 3-(3',4'-dichlorophenyl)-1,1-dimethylurea plus hydroxylamine and by increasing light intensity produces only minor changes in the almost constant fast- and medium-lifetime components; however, there is a dramatic increase in the yield of the slow component, by a factor of about 20, accompanied by only a modest increase in the lifetime to 2200 ps (F/sub max/). In good agreement with previous fluorescence lifetime measurements, researchers find an increase in the averaged lifetime of the three components from 0.5 to 2.0 ns, which is proportional to the 4-fold increase in the total fluorescence yield. Time-resolved results are inconsistent with models which are based on the proportionately between lifetime and yield and which involve a homogeneous origin of fluorescence that is sensitive to the state of the reaction centers. Researchers conclude that the variable part of the fluorescence, which is dominated by the slow phase, reflects the kinetics of charge recombination in the reaction center, as proposed previously. The modest increase in lifetime of the slow phase indicates the presence of some energy transfer between photosynthetic units.

5503 Cytology

REFER ALSO TO CITATION(S) 30403, 30404, 30435, 30558

30418 (LA—9479-PR, pp 3-6) **Multiparameter cell sorter II.** Martin, J.C.; Wilder, M.E.; Jett, J.H. Oct 1982. NTIS, PC A08/MF A01.

In Los Alamos Life Sciences Division's biomedical and environmental research programs. Progress report, January-December 1981.

The Sorter II system is a multiparameter computer based cell sorter based on the Los Alamos style enclosed flow chamber. The major improvement to the Sorter II system during the past year has been the addition of a Spectra-Physics model 164-05 argon-ion laser enhanced for uv operation having an output power in excess of 100 mW for the 352 to 361 nm lines. Measurements of the dynamics of changing fluorescence emission from populations of cells has continued to be a useful flow cytometry technique for studies of enzyme activities and studies of the kinetics of staining reactions. (DLS)

30419 (LA—9479-PR, pp 6-7) **High-speed cell selection.** Martin, J.C.; Stewart, C.; Jett, J.H. Oct 1982. NTIS, PC A08/MF A01.

In Los Alamos Life Sciences Division's biomedical and environmental research programs. Progress report, January-December 1981.

A new technique for super high-speed cell selection is being investigated for the sorting of viable cells. The selection method will be based on a technique of cell destruction with a goal of analyzing and selecting cells at rates of 100,000 cells per second. The most promising means of producing sufficient damage to the cell with the band of laser lines in the 350 to 360 nm region available with argon-ion lasers is by irradiating cells stained with the viable DNA specific dye Hoescht-33342. (DLS)

30420 (LA—9479-PR, pp 7) **Los Alamos cell analysis (LACEL) flow cytometry data acquisition system.** Wilkins, S.F. Oct 1982. NTIS, PC A08/MF A01.

In Los Alamos Life Sciences Division's biomedical and environmental research programs. Progress report, January-December 1981.

The Los Alamos Cell Analysis (LACEL) data acquisition and processing system is now operational on four cell sorters at Los Alamos. The system can acquire up to 8 parameter list mode data and control left and right sorting on up to four parameters for each direction. The software has been distributed to several laboratories in the US and elsewhere.

30421 (LA—9479-PR, pp 81-84) **Optimization of culture conditions for the growth of rat bone marrow and alveolar macrophages.** Saunders, G.C.; Martinez, A. Oct 1982. NTIS, PC A08/MF A01.

In Los Alamos Life Sciences Division's biomedical and environmental research programs. Progress report, January-December 1981.

A library of methodologies is being developed to answer questions regarding the toxicity of inhaled pollutants relevant to the oil shale industry. One measure of toxic exposure is to evaluate the clonogenicity of macrophages present in exposed animals compared to that in control animals of a similar age and genetic makeup. The Fisher 344 rat has been chosen as the experimental animal used in inhalation studies at Los Alamos. Data in literature concerning the culture of rat macrophages are very limited; researchers therefore proceeded to define and optimize requirements for their culture.

30422 (LA—9479-PR, pp 84-86) **Differentiation of mononuclear phagocytes.** Stewart, C.C.; Walker, E.; Walker, W. Oct 1982. NTIS, PC A08/MF A01.

In Los Alamos Life Sciences Division's biomedical and environmental research programs. Progress report, January-December 1981.

The mononuclear phagocyte system is being used as a model system to understand normal cell differentiation because of the diversity of functions these cells express. This diversity can be

thought to occur in several ways. First, expression of any function can represent a differentiated state through which all cells pass. Second, it could represent differentiation of progenitor cells into subpopulations which express a particular function; each functional subpopulation would sum together in the whole population to manifest the functional heterogeneity observed. Third, tissue-specific substances may induce or modulate functional expression. Finally, any combination of the three above processes may occur. In order to evaluate which of the possibilities are manifested, researchers have selected surface membrane markers as a sign to identify macrophages within a particular population. Since the legends to the markers can be fluoresceinated, it is possible to identify and sort the subpopulations using flow cytometry.

30423 (LA—9479-PR, pp 86-87) **Proliferation kinetics of mononuclear phagocytes of the bone marrow.** Stewart, C.C.; Stewart, S.J. Oct 1982. NTIS, PC A08/MF A01.

In Los Alamos Life Sciences Division's biomedical and environmental research programs. Progress report, January-December 1981.

Bone marrow cells were derived from C_3H mice and cultured in growth media to study the proliferation kinetics of mononuclear phagocytes. This cell system was studied because: it is a unique normal cell system which can be used to identify mechanisms of proliferation control, large numbers of homogenous populations of functional cells can be obtained, and the senescence of cell division leading to an understanding of the aging process can also be studied. (DLS)

30424 (LA—9479-PR, pp 97-100) **Rapid staining procedures for analysis of cellular DNA and protein by single and dual laser flow cytometry.** Crissman, H.A.; Kissane, R.J.; Steinkamp, J.A. Oct 1982. NTIS, PC A08/MF A01.

In Los Alamos Life Sciences Division's biomedical and environmental research programs. Progress report, January-December 1981.

Simultaneous flow-cytometry (FCM) analysis of cells stained for both DNA and protein can reveal subpopulations of different protein content located throughout the cell cycle or within aneuploid cell populations. Additional descriptive information such as the nuclear-to-cytoplasmic relationship and the DNA-to-protein ratios for subpopulations can also be determined by flow cytometry and this approach can further enhance the analysis of heterogeneous cell populations. Studies have focused on the development of two-color DNA-protein staining methods for use in the dual laser FCM system. With this system dyes with different excitation wavelengths such as mithramycin (MI) and rhodamine 640 (R 640) or substituted rhodamine isothiocyanate (X RITC) may be used for staining cellular DNA and protein, respectively. Alternatively the DNA reactive fluorochrome Hoechst 33342 (HO) may also be used in combination with R 640 or X RITC. One main advantage of using MI or HO is that these fluorochromes are highly specific for cellular DNA, thus RNase treatment is not required. Cell staining is performed, in most cases, on ethanol-fixed cells; however, in one protocol, HO and R 640 were used to stain unfixed cells. In all cases the cells were stained and analyzed in the combined stain reagents. MI-stained cells were excited at 457.9 nm, HO-stained cells at 350 to 365 nm (combined laser lines) and R 640- or XRITC-stained cells at 568 nm.

30425 (LA—9479-PR, pp 100-102) **Flow analysis of karyotype instability.** Bartholdi, M.; Cram, L.S. Oct 1982. NTIS, PC A08/MF A01.

In Los Alamos Life Sciences Division's biomedical and environmental research programs. Progress report, January-December 1981.

Investigations designed to evaluate the significance of karyotype instability have concluded that (1) some degree of non-random chromosome change is observable, and (2) karyotype changes occurring at low frequency and involving potentially small aberrations must be analyzed as they first appear in spontaneously developing tumors to be able to answer the question of the role of karyotype instability in tumorigenesis. To do so has required the development of (1) a model system in which cells spontaneously progress from normal euploid cells to tumor producing cells, and (2) specialized flow cytometric instrumentation for quantitating several properties of individual chromosomes at very high analysis rates. The model system of spontaneous tumor development (whole Chinese hamster embryo cells, WCHE) has been described previously. The specialized flow-cytometric instrumentation designed to make high resolution and morphological measurements of isolated chromosomes is described.

30426 (LA—9479-PR, pp 102-103) **Flow-cytometric analysis of cultured bone marrow mononuclear phagocytes.** Stewart, C.C.; Stewart, S.J. Oct 1982. NTIS, PC A08/MF A01.

In Los Alamos Life Sciences Division's biomedical and environmental research programs. Progress report, January-December 1981.

Using flow cytometry, the autofluorescent profile of two populations of culture derived mononuclear phagocytes have been analyzed. Data show that mature macrophages can be distinguished from their progenitor cells on the basis of autofluorescence. They illustrate a potential problem in studying membrane markers using fluorescent probes; namely, due to high degree of autofluorescence, it is possible that low density receptors will not be resolved by fluorescent probes because the autofluorescence will be too high a proportion of total fluorescence. (DLS)

30427 (LA—9479-PR, pp 103-105) **Flow-cytometric analysis of human lymphocyte spheroids.** Stewart, C.C.; Steinkamp, J.A. Oct 1982. NTIS, PC A08/MF A01.

In Los Alamos Life Sciences Division's biomedical and environmental research programs. Progress report, January-December 1981.

When human peripheral blood mononuclear cells (MNC) are cultured at low concentration and density with phytohemagglutinin they were found to form discrete spheroids. Briefly, 2 x 10^5 MNC were cultured in 3.5 ml αMEM containing 3% FBS and 6 μg PHA/ml in 35-mm culture dishes. Each day replicate cultures were analysed. Free cells and cell clusters (spheroids) were suspended gently and fixed in 1% glutaraldehyde in situ for 1 h and then overnight in 70% ethanol. By carefully resuspending other cultures so as not to disaggregate spheroids, it was possible to separate the free cells from the spheroids and quantify the production of each population separately. A special flow cell with a 500-μm diameter orifice was used to allow spheroids to pass. The laser beam was shaped to produce a near planar beam of approximately 10 x 500 μm at the intersection of the cell stream. Cells were diluted to about 10^5 particles per ml and the flow rate was adjusted to minimize coincidence.

30428 (LA—9479-PR, pp 105-108) **Sequential detection and analysis of multiple electronic and optical measurements on cells.** Steinkamp, J.A. Oct 1982. NTIS, PC A08/MF A01.

In Los Alamos Life Sciences Division's biomedical and environmental research programs. Progress report, January-December 1981.

Flow-cytometric experiments often require multiple electrical and optical measurements to determine cytological, biochemical, and functional properties of cells. Depending upon flow cell geometry, electrical and optically sensed signals normally occur sequentially. Therefore, electronics are required to sense, acquire, and temporarily store peak signal amplitudes which are separated in time for processing as frequency distribution histograms. This report illustrates the use of versatile electronics for coherently processing six sequentially occurring signals from electronic cell-size and optical sensors.

30429 (LA—9479-PR, pp 110-112) **Emergence of permanent cell lines from cultured diploid cell strains.** Kraemer, P.M.; Travis, G.L. Oct 1982. NTIS, PC A08/MF A01.

In Los Alamos Life Sciences Division's biomedical and environmental research programs. Progress report, January-December 1981.

Permanent, aueuploid cell lines often emerge in monolayer cell cultures initiated with normal, diploid rodent cells. It is well documented that such cell lines frequently become tumorigenic spontaneously with passage in culture. Cultured cell strains that do not generate permanent cell lines, such as human diploid cels, are relatively resistant to induced malignant transformation. Hence, the emergence of permanent cell lines from diploid cell strains is cur-

rently viewed by some workers as a preneoplastic event. Both the cell line emergence phenomenon, as well as the further progression to frank tumorigenicity appear to be quite variable. The report describes attempts to determine whether this variability would be eliminated in replicate cultures of a given normal diploid cell population.

30430 **The role of glucose in the growth of 9L multicell tumor spheroids.** Li, C.K.N. (Univ. of Rochester School of Medicine and Dentistry, NY). *Cancer (Philadelphia);* **50**: No. 10, 2074-2078(15 Nov 1982).

Monolayer-cultured 9L rat brain tumor cells grew optimally in culture media containing glucose concentrations greater than 0.07 mg/ml, but growth ceased at concentrations lower than this value. Assuming that this glucose concentration defines the proliferating fraction of cells in 9L multicell tumor spheroids, it is possible to simulate spheroid growth based on the intraspheroid glucose distribution derived by the author earlier. An excellent fit to experimental growth data was obtained by assigning the proliferating fraction a growth rate constant equal to 40% of that of monolayer-cultured cells. This definition is in accord with our observation that the colony-forming efficiency (CFE) of spheroid-derived cells is 40% of the CFE of cells maintained in monolayer. This suggests that the role of glucose in 9L cell growth is similar in spheroids and in monolayer culture.

30431 **Role of anchorage in the expression of tumorigenicity of untransformed mouse cell lines.** Wells, R.S. (Univ. of Colorado Medical Center, Denver); Campbell, E.W.; Swartzendruber, D.E.; Holland, L.M.; Kraemer, P.M. *JNCI, Journal of the National Cancer Institute;* **69**: No. 2, 415-423(Aug 1982). Contract W-7405-ENG-36.

Cultured mouse cells were tested for tumorigenicity in nude mice with both a conventional assay (injection of cell suspensions) and a new test involving implantation of cells grown on gelatin sponges. Sublines of Balb/3T3 cells, obtained from different sources, varied in their tumorigenic potential with either assay. One subline (A) formed distinctive precancerous nodules only in the sponge assay; these nodules often became progressive after a latent period of 3-4 months. However, suspensions of cells of this subline also caused tumors after a similar latent period, but no nodular phase preceded tumor formation. Another subline of Balb/3T3 (M) has failed to form tumors in either assay. The Balb/3T3 sublines did not differ in in vitro properties, such as low saturation density, failure to grow in methylcellulose, and monolayer morphology. A second experimental approach involved tests on nude BALB/c mouse-embryo fibroblasts at various passage levels. The cells were passaged from primary culture, through crisis, to heteroploid, established cell lines. Tumorigenicity was demonstrable earlier in the sponge assay, at which time in vitro parameters putatively associated with malignant behavior were unchanged. Possible relationships with the in vivo phenomenon of solid-surface sarcomagenesis are discussed.

30432 **A method of resuspending small vesicles separated from suspension by protamine aggregation and centrifugation.** Gunter, K.K.; Gunter, T.E.; Jarkowski, A.; Rosier, R.N. (Univ. of Rochester, NY). *Analytical Biochemistry;* **120**: 113-124(1982). Contract AC02-76EV03490.

The technique of separating small vesicles from suspension by aggregation with protamine or polylysine, followed by either filtration or centrifugation has proved a very useful one. This is because the minimum times necessary to separate vesicles from the suspending medium are quite short (15 to 30 s) and the separation is almost complete (over 98% in the cases tested). The primary limitation of this technique, until now, has been that it could only be used for a terminal assay, because the aggregates produced could not be easily disaggregated. It has been found that after aggregation of vesicles by protamine and their separation from suspension by low-speed centrifugation, the addition of an excess of heparin over protamine, followed by vortexing or homogenizing the pellet in fresh medium, satisfactorily disaggregates the vesicles. This process has been tested with phospholipid vesicles and proteoliposomes and with vesicles from inner mitochondrial membrane, sacroplasmic reticulum, and red blood cell membrane, producing satisfactory resuspensions in all cases tested. Leakage of [^{14}C]sucrose or $^{86}Rb^{+}$ from phospholipid vesicles was not found to be significantly more rapid from protamine-heparin-treated vesicles, than from similar vesicles treated with protamine alone or from untreated control vesicles. Good separation of the resuspended vesicles from the remaining protamine and heparin was obtained with phospholipid vesicles and proteoliposomes using a gel filtration technique. Most of the protamine and heparin could be removed from the vesicles made of natural biological membrane using a combination of ion exchange chromatography and gel filtration.

30433 **Is the central dogma of flow cytometry true: that fluorescence intensity is proportional to cellular dye content.** Kerker, M.; Van Dilla, M.A.; Brunsting, A.; Kratohvil, J.P.; Hsu, P.; Wang, D.S.; Gray, J.W.; Langlois, R.G. (Lawrence Livermore National Lab., CA). *Cytometry (Baltimore);* **3**: No. 2, 71-78(1982). Contract W-7405-ENG-48.

Measurements and theoretical calculations of fluorescent emission from four samples of polystyrene microspheres (diameter 0.92, 1.63, 1.90 and 4.18 μm) containing the same fluorescent dye show a general dependence upon particle size, emission angle, and polarization conditions. However, for the excitation and detection conditions used in flow cytometry, the relative fluorescent intensities measured for the four particle sizes are proportional to the dye content to +10% accuracy, independent of particle size. Accordingly, the central dogma of flow cytometry that fluorescence is proportional to cellular dye content is valid to this accuracy for these solid, highly refractive polymer particles. Most mammalian cells are much less refractive, therefore, should conform more closely to the central dogma.

5504 Genetics

REFER ALSO TO CITATION(S) 30402, 30410, 30449, 30540, 30573, 30575

30434 **(DOE/ER/10888—T1) Genetic engineering with a gene encoding a soybean storage protein. Progress report.** Beachy, R.N. (Washington Univ., St. Louis, MO (USA)). 1983. Contract AC02-81ER10888. 11p. NTIS, PC A02/MF A01. Order Number DE83010115.

Portions are illegible in microfiche products.

Progress is reported in gene transfer experiments using the soybean seed storage protein gene. The sequencing of gene Gmg α′ 17.1 has been completed. Several deletion mutants of this gene are being prepared for experiments to transfer the gene into the Ti-plasmid of Agrobacterium tumefaciens. The purpose is to determine which, if any, of the upstream sequences are those which regulate the developmental expression of the gene. (ACR)

30435 **(LA—9479-PR, pp 6) Chromosome sorting for genomic cloning of mammalian DNA.** Jett, J.J.; Wilder, M.E.; Cram, L.S. Oct 1982. NTIS, PC A08/MF A01.

In Los Alamos Life Sciences Division's biomedical and environmental research programs. Progress report, January-December 1981.

Cloned DNA from specific chromosomes will provide the means to answer a variety of fundamental and applied questions concerning the packaging of DNA in mammalian chromosomes and the relationships between packaging and gene expression. Once obtained in large quantities by recombinant techniques, the chromosome specific DNA will be used to analyze differences in DNA sequenced between normal and abnormal cells, to determine information content of specific chromosomes. In order to build libraries of the genomic information in individual chromosomes, sufficient quantities of purified chromosomes must be obtained. Using the Chinese hamster cell line M-31 as a source of material, approximately 6 μg of each of chromosomes number 1 and 2 have been obtained to construct the initial libraries. These quantities were sorted with a modified commercial flow cytometer (Becton-Dickinson FACS-II) using the Los Alamos developed LACEL data acquisition and sorting control system.

30436 **Apomictic interspecific hybrids between pearl millet and Pennisetum orientale L. C. Rich.** Hanna, W.W.; Dujardin, M. (Univ. of Georgia, Tifton). *Crop Science;* **22**: No. 4, 857-859(Jul 1982). Contract AS09-76EV00637.

Pearl millet, Pennisetum americanum (L.) Leeke, is an important world food and forage crop. Pennisetum orientale L. C. Rich. has genes for apomixis, perennial growth habit, pest resistance, and drought tolerance which could be used to improve pearl millet. The objectives of this research were to determine the cytotaxonomic relationship of these two species and to explore the feasibility of interspecific germplasm transfer. Five interspecific hybrids, 2n = 25, with 7 large P. americanum millet (A) and 18 small P. orientale (O) chromosomes were produced by pollinating cytoplasmic male sterile pearl millet with P. orientale pollen. The O chromosomes paired mainly as bivalents and the A chromosomes remained as univalents. A low frequency of AO chromosome associations were observed. Although the possibility of germplasm exchange existed, the two species appeared to be not closely related. Among three hybrids examined, one was a facultative apomict, one was an obligate apomict and another was highly apomictic with 3% of ovules with sexual embryo sacs. Sixteen backcross progenies were established from interspecific hybrids pollinated with pearl millet pollen. Seven plants were 2n = 23 with 14 A + 9 O chromosomes, five were 2n = 27 with 7 A + 20 O chromosomes and four were 2n = 32 with 14 A and 18 O chromosomes. The balanced chromosome number for both species in these latter plants should provide a mechanism for restoring fertility in the interspecific hybrid thus enabling germplasm transfer. The interspecific hybrids were male sterile but set about 1% seed when pollinated with pearl millet pollen.

30437 **Stable cytoplasmic male-sterile mutants induced in Tift 23DB$_1$ pearl millet with mitomycin and streptomycin.** Burton, G.W.; Hanna, W.W. (Univ. of Georgia, Tifton). *Crop Science;* **22**: 651-652(May-Jun 1982). Contract AS09-76EV00637.

Stable cytoplasmic male-sterile lines are necessary for the commercial production of F_1 hybrid seed of important crop plants such as sorghum (Sorghum bicolor L.) and pearl millet [Pennisetum americanum (L.) Leeke.]. The objective of this investigation was to ascertain if streptomycin and mitomycin could help to create stable cms mutants. Seeds of Tift 23DB$_1$ pearl millet were soaked in water solutions of 200 and 500 ppM of streptomycin, and 50 ppM of mitomycin at 5 C for 40 hours. Treated seeds were rinsed in tap water, surface dried, and planted in an isolated field along with a check of untreated seed. Head populations of 32,800, 22,300, 18,000, and 13,000 from seed treated with 0, 200, 500 ppM of streptomycin and 50 ppM of mitomycin contained progeny tested stable cytoplasmic male-sterile (cms) mutants at frequencies of 1 in 16,200, 5575, 4500, and 2600, respectively. The sterility or fertility of cms mutants crossed with 2 sterility maintainers and 6 fertility restorer inbreds of pearl millet suggests that the induced mutants have sterility maintainer and fertility restorer requirements similar to cms Tift 23DA$_1$ and are similar cms mutants.

30438 **Molecular mechanism of extinction of liver-specific functions in mouse hepatoma x rat fibroblast hybrids: extinction of the albumin gene.** Papaconstantinou, J. (Oak Ridge National Lab., TN); Wong, E.; Ratrie, H.; Szpirer, C.; Szpirer, J. *Somatic Cell Genetics;* **8**: No. 3, 363-376(1982).

Hybrids formed by the fusion of mouse hepatoma (BWTG3) and rat fibroblast (JF1) cells exhibit the extinction of mouse albumin and α-fetoprotein synthesis. Karyotype analyses suggest that all parental chromosomes are present in the hybrids. The extinction, therefore, of mouse hepatocyte genes is attributed to the inhibitory action of the rat genome. In these studies, we show that these hybrids possess and express the mouse β-glucyronidase gene (which is encoded on the same chromosome as the mouse albumin and α-fetoprotein gene), and we present data of Southern blot analysis which demonstrate that such hybrids have indeed retained both mouse and rat albumin DNA sequences. In addition, using mouse albumin cDNA, we have shown by cDNA-RNA reassociation kinetics that albumin mRNA is virtually absent in these hybrids. We conclude from these studies that the extinction of albumin synthesis involves a mechanism which results in the loss of cytoplasmic albumin mRNA.

30439 **Modification of chlorophyll striping by the R region.** Kermicle, J.L. (Univ. of Wisconsin, Madison); Axtell, J.D. *Maydica;* **26**: 185-197(1981). Contract AC02-76EV01300.

A gene very closely linked to R on chromosome 10 inhibits albino striping in plants homozygous for the striate-2 mutation. A marked reduction in leaf blade width accompanies inhibition. Level of inhibition is dosage dependent but is not correlated one to one with R plant or seed pigmenting potential. The inhibitor maps within the duplicated segment of the R-r-standard chromosome. Differential sr2 modification provides a means of discriminating among isoallelic R accessions and derivatives.

5505 Metabolism

REFER ALSO TO CITATION(S) 30567, 30568, 30569, 30570

30440 **(LBL—15715) Path of carbon: from stratosphere to cell.** Calvin, M. (Lawrence Berkeley Lab., CA (USA)). Jan 1983. Contract AC03-76SF00098. 54p. (CONF-830137—1). NTIS, PC A04/MF A01. Order Number DE83009947.

From 15. symposium on advances in gene technology: molecular genetics of plants and animals; Miami, FL, USA (17 Jan 1983).

A brief history is presented of the evolution of knowledge of how plants manufacture from carbon dioxide and water all their substances. From this base is traced a route to a totally synthetic system which will use sunlight to generate fuel and chemicals. (ACR)

30441 **The glucose distribution in 9L rat brain multicell tumor spheroids and its effect on cell necrosis.** Li, C.K.N. (Univ. of Rochester School of Medicine and Dentistry, NY). *Cancer (Philadelphia);* **50**: No. 10, 2066-2073(15 Nov 1982).

The glucose consumption rate of 9L rat brain tumor cells was determined as a function of concentration. Glucose uptake followed Michaelis-Menten kinetics with a K/sub m/ of 0.58 mM and a v/sub max/ of 1.6 pg/cell-min. The glucose diffusion coefficient in spheroids of 9L tumor cells was determined to be 1.5 x 10^{-6} cm^2/s at 37°C. Using these parametric values, the glucose distribution in 9L multicell spheroids was calculated and related to the viable and necrotic zones.

30442 **Use of radioisotopes in quantitative studies of lung metabolism.** Rannels, D.E. (Pennsylvania State Univ. College of Medicine, Hershey); Low, R.B.; Youdale, T.; Volkin, E.; Longmore, W.J. *Federation Proceedings;* **41**: No. 12, 2833-2839(Oct 1982). Contract W-7405-ENG-26.

Quantitatively accurate studies of macromolecule and lipid synthesis in lung and other tissues by using radioactive substrates require detailed knowledge of the specific radioactivity of the appropriate pool of precursor molecules serving the synthetic pathway. A brief summary is provided of how considerations of precursor availability, metabolism, and compartmentation, as well as product remodeling, may affect the accuracy with which rates of protein, DNA, RNA, and lipid synthesis can be measured. Where possible, the application of this material to studies of lung metabolism is discussed, along with approaches that may minimize experimental uncertainties.

30443 **Resistance to injury by sulfur dioxide.** Sekiya, J.; Wilson, L.G.; Filner, P. (Michigan State Univ., Dept. of Energy Plant Research Lab., East Lansing). *Plant Physiology;* **70**: No. 2, 437-441(Aug 1982). Contract AC02-76ER01338.

In Cucurbitaceae young leaves are resistant to injury from acute exposure to SO_2, whereas mature leaves are sensitive. After exposure of cucumber (Cucumis sativus L.) plants to SO_2 at injurious concentrations, illuminated leaves emit volatile sulfur, which is solely H_2S. Young leaves emit H_2S many times more rapidly than do mature leaves. Young leaves convert approximately 10% of absorbed [^{35}S]SO_2 to emitted [^{35}S]H_2S, but mature leaves convert less than 2%. These results suggest that a high capability for the reduction of SO_2 to H_2S and emission of the H_2S is a part of the biochemical basis of the resistance of young leaves to SO_2.

30444 **Photosynthetic carbon metabolism in the submerged aquatic angiosperm Scirpus subterminalis.** Beer, S.; Wetzel, R.G. (Michigan State Univ., Hickory Corners). *Plant Science Letters;* 21: 199-207(1981).

Scirpus subterminalis Torr., a submerged angiosperm abundant in many hardwater lakes of the Great Lakes region, was investigated for various photosynthetic carbon fixation properties in relation to available inorganic carbon and levels of carbon fixing enzymes. Photosynthetic experiments where CO_2 and HCO_3^- were supplied at various concentrations showed that Scirpus was able to utilize HCO_3^- at those concentrations close to natural conditions. However, when CO_2 concentrations were increased above ambient, photosynthetic rates increased markedly. It was concluded that the photosynthetic potential of this plant in many natural situations may be limited by inorganic carbon uptake in the light.

5506 Medicine

REFER ALSO TO CITATION(S) 30241, 30304, 30484, 30581

30445 **(IPEN-Inf—04) Preparation of a sup(99m) Tc generator for use in nuclear medicine, using calcinated (1000°C) alumina as an adsorber for ^{99}Mo.** Gasiglia, H.T.; Enoshita, M. (Instituto de Pesquisas Energeticas e Nucleares, Sao Paulo (Brazil)). Dec 1980. 15p. (In Portuguese). NTIS (US Sales Only), PC A02/MF A01. Order Number DE83701512.

The preparation of ^{99} sup(m) Tc generator using calcinated (1000°C) alumina as adsorber for ^{99}Mo is described. The adsorption of ^{99}Mo and the elution of ^{99} sup(m) Tc were studied. When the generator is autoclaved (30 minutes, 121°C), after the loading of ^{99}Mo, elution yields of ^{99} sup(m) Tc fall to the half if compared whith generators not autoclaved. However, by autoclaving ^{99}Mo loading solution and alumina column separately and than preparing the generator, 80% elution yields of ^{99} sup(m) Tc were obtained. The contamination of the generator by microorganism is avoided when the loading of the ^{99}Mo is carried out in a hot-cell under UV ligth. The radioactive, radiochemical, chemical and microbiological purity criteria were examined for ^{99} sup(m) Tc solutions. The generator is considered safe for medical purposes.

30446 **Decreased incidences of neoplastic transformation in vitro following irradiation with multiple fractions of ^{60}Co γ-rays. Abstract no. 48.** Hill, C.K.; Buonaguro, F.M.; Han, A.; Elkind, M.M. (Argonne National Lab., IL (USA)). *Breast Cancer Research and Treatment;* 2: No. 3, 288(1982).

From 5. Annual breast cancer symposium; San Antonio, TX (USA) (5 - 6 Nov 1982).

Published in summary form only.

5507 Microbiology

REFER ALSO TO CITATION(S) 30524

30447 **(DOE/EV/10413—1) Collection of phytoplankton by centrifugation in gradients of Percoll. Final report.** Price, C.A.; Reardon, E.M.; Guillard, R.R.L. (Rutgers--the State Univ., Piscataway, NJ (USA). Waksman Inst. of Microbiology; Woods Hole Oceanographic Institution, MA (USA)). Mar 1983. Contract AC02-80EV10413. 13p. NTIS, PC A02/MF A01. Order Number DE83009530.

Most marine phytoplankton can be recovered from laboratory cultures and from natural waters by isopycnic sedimentation in density gradients of Percoll, a modified silica sol. The report describes modifications of commercial centrifuges and rotors that permit the separation and recovery of phytoplankton from volumes of sea water ranging from 80 to 600 ml. The zones of phytoplankton can be detected by passing the gradients through flow cells adapted for a commercial fluorometer. The algal cells band in discrete zones and may be recovered structurally and physiologically intact. The general methods described should be useful in moitoring the distribution of phytoplankton in natural waters and in concentrating for identification and subsequent culture organisms that are normally present at high dilution.

30448 **(LA—9479-PR, pp 118-119) Biochemical synthesis with stable isotopes.** Kollman, V.H.; Whaley, T.W. Oct 1982. NTIS, PC A08/MF A01.

In Los Alamos Life Sciences Division's biomedical and environmental research programs. Progress report, January-December 1981.

Descriptions of the biochemical synthesis of glucose-$^{13}C_6$ from Agmenellum quadruplication; the biochemical labelling of [^{13}C, ^{15}N] Chlorella and [^{13}C] E. coli, [^{15}N] E. coli, and the production of lactic-$^{13}C_3$ acid utilizing Lactobacillus casei are discussed. (DLS)

30449 **Differential accumulation of two apo-iso-cytochromes c in processing mutants of yeast.** Matner, R.R.; Sherman, F. (Univ. of Rochester School of Medicine and Denistry, NY). *Journal of Biological Chemistry;* 257: No. 16, 9811-9821(1982). Contract AC02-76EV03490.

Mutations at the structural gene, CYC1, for iso-1-cytochrome c and at the structural gene, CYC7, for iso-2-cytochrome c can reduce the levels of the respective proteins by varying degrees in the yeast Saccharomyces cerevisiae. Mutations at two other loci, cyc2 and cyc3, that are unlinked to either of the structural genes, specifically reduce the levels of both iso-cytochromes c; cyc2 mutations can also cause complete deficiencies. Researchers have explored the possibility that the CYC2 and CYC3 loci code for maturation functions involved in the biosynthesis of cytochrome c. Researchers propose that the CYC3 locus codes for a heme attachment activity. Evidence is presented indicating that the CYC2 gene product may be a protein which facilitates apo-cytochrome c transport across the outer mitochondrial membrane or enhances the heme attachment activity. It is unknown why apo-iso-1-cytochrome c does not accumulate in mutants that allow accumulation of apo-iso-2-cytochrome c.

30450 **Homologies of Neurospora homothallic species using repeated and nonrepeated DNA sequences.** Williams, N.P.; Mukhopadhyay, D.; Dutta, S.K. (Howard Univ., Washington, DC). *Experientia;* 37: 1157-1158(1981).

DNA:DNA hybridization studies of the homothallic species of Neurospora showed that the repeated DNA sequences provided no means of distinction among them. Hybridization with nonrepeated DNA sequences, however, showed that the N. Terricola species was quite unlike the others. These studies suggest that heterothallism might have evolved from homothallism in Neurospora.

30451 **Physiology of thermophilic bacteria.** Ljungdahl, L.G. Athens, GA; University of Georgia ([nd]). 95p. Contract AS09-76ER00888.

Bacteria are classified into at least 3 groups depending on their cardinal temperatures. Bacteria with growth spans from 40°C to 80°C are classified as thermophiles. It is the physiology of this group which is the subject of this review which has nearly 400 references. Topics covered in some detail include a description of the properties of some thermophiles, the properties of macromolecules and structures in thermophiles, the metabolism and enzymes of thermophiles, and thermoadaptation, and the genetic transfer of thermophilicity.

5508 Morphology

REFER ALSO TO CITATION(S) 30416

5509 Pathology

REFER ALSO TO CITATION(S) 29080, 30459

30452 **(IFIP-R—64) In vivo mutagenicity studies in rats mice and Chinese hamsters fed irradiated foodstuffs - chicken, fish, dates, pulses, mangoes and cocoa beans.** Renner, H.W. (International Project in the Field of Food Irradiation, Karlsruhe (Germany, F.R.)). Nov 1982. 18p. Available from Bundesforschungsanstalt fuer Ernaehrung, Karlsruhe (Germany, F.R.).

Three in vivo genetic toxicity tests were performed in rats, mice and Chinese hamsters to detect possible mutagenic effects of irradiated chicken, dried dates, fish, cocoa beans, pulses and mangoes. The tests employed were the micronucleus test and sister-chromatid exchange (SCE) test for irradiated and unirradiated samples of all foodstuffs listed, and the spermatogonia test, (including SCE technique) in mice for irradiated and unirradiated chicken, fish and dates only. In the case of cocoa beans, the mutagenicity tests were performed on an additional test group fed beans fumigated with ethylene oxide. The different mammalian species used for the various experiments are given below. None of the tests provided any evidence of mutagenicity induced by irradiation in any of the foodstuffs studied. Moreover, these tests are currently considered to be the most sensitive in vivo mutagenicity tests in mammals.

30453 **Hematologic and serum chemical characteristics of mononuclear leukemia in Fischer 344 rats.** Kusewitt, D.F.; Hahn, F.F.; Pickrell, J.A. (Lovelace Biomedical and Environmental Research Inst., Albuquerque, NM). *Laboratory Animal Science;* 275-277(1982). Contract AC04-76EV01013.

Hematologic, serum chemical, and histopathologic studies were performed on 17 aged Fischer 344 rats with mononuclear leukemia. Twelve of the rats had leukemic hemograms, while five had nonleukemic or marginally abnormal differential leukocyte counts. Hematologic findings revealed that all rats were profoundly anemic. Serum chemistry studies confirmed the occurrence of icterus observed clinically, a finding consistent with hemolytic anemia. Alanine aminotransferase and serum alkaline phosphatase values were elevated.

5510 Physiological Systems

REFER ALSO TO CITATION(S) 30408, 30415, 30417

30454 (LA—9479-PR, pp 108-110) **Infiltration of host defense cells into a foreign substratum.** Stevenson, A.P.; Bame, K.J.; Travis, G.L.; Kraemer, P.M. Oct 1982. NTIS, PC A08/MF A01.

In Los Alamos Life Sciences Division's biomedical and environmental research programs. Progress report, January-December 1981.

A system employing surgical sponges (Gelfoam) has been used to determine the host's response on sponges implanted subcutaneously into nude mice. Histological examination during such studies has shown that a host response develops and that this response included infiltration of host macrophages and fibroblasts. Blank sponges were hydrated in growth medium and then blotted on sterile gauze before implanting into nude mice as well as into standard hairy BALB/c mice. At 1, 2, 3, 7, or 10 days after implantation, the sponges were explanted and dissolved using trypsin, collagenase, and EDTA (TCE). A heavy infiltration of cells was found, followed by a drop in total cell number on days 2 and 3. Results suggest that host defense cells not only infiltrate an implanted substratum but are also capable of proliferating, thereby increasing the potential for the involvement of these cells in the host defense mechanism. We are currently investigating whether these macrophages can be activated to tumoricidal activity in vitro.

30455 (LA—9479-PR, pp 139) **Physiologic response of elk to variations in winter range quality.** Weber, B.J.; White, G.C. Oct 1982. NTIS, PC A08/MF A01.

In Los Alamos Life Sciences Division's biomedical and environmental research programs. Progress report, January-December 1981.

Thirty-six elk were live-trapped during February to April 1980, approximately 2.5 years after the La Mesa fire. Twenty elk were captured on Burnt and Escobas Measas at Bandelier National Monument (BURN). The remaining elk were caught on the Valle San Antonio (BACA), an unburned winter range. Comparisons of body conditions between elk wintering on the BURN and those wintering on the BACA were made using a 3-way analysis of variance (location, age, sex) model that incorporated the covariates of day and time of capture.

30456 (LA—9479-PR, pp 140-141) **Nitrogen-nutritional strategies of plants, in natural ecosystems and in agriculture.** Gutschick, V.P. Oct 1982. NTIS, PC A08/MF A01.

In Los Alamos Life Sciences Division's biomedical and environmental research programs. Progress report, January-December 1981.

The experiments to discover and quantify the evolved strategies of selective root growth for mineral nutrition are well advanced. Rapid, physiologically normal growth was achieved in hydroponic culture without problems of disease, algal contamination, trace-element stress, or root-temperature control. The preliminary growth patterns of roots and of whole plants according to joint variations of nitrogen and phosphorus supplies are well-differentiated. Chemical and physical methods of analyzing nutrient usage, tissue nutrient content, and tissue growth rates have been tested and verified.

30457 **Longevity of guard cell chloroplasts in falling leaves: implication for stomatal function and cellular aging.** Zeiger, E.; Schwartz, A. (Stanford Univ., CA). *Science (Washington, D.C.);* **218**: 680-682(12 Nov 1982).

Guard cell chloroplasts in senescing leaves from 12 species of perennial trees and three species of annual plants survived considerably longer than their mesophyll counterparts. In Ginkgo biloba, stomata from yellow leaves opened during the day and closed at night; guard cell chloroplasts from these leaves showed fluorescence transients associated with electron transport and photophosphorylation. These findings indicate that guard cell chloroplasts are highly conserved throughout the life-span of the leaf and that leaves retain stomatal control during senescence.

30458 **Effect of age on respiratory function of Fischer-344 rats.** Mauderly, J.L. (Lovelace Biomedical and Environmental Research Inst., Albuquerque, NM). *Experimental Aging Research;* **8**: No. 1, 31-36(1982). Contract AC04-76EV01013.

The respiratory function of adult male and female specific pathogen free Fischer-344 rats in three age groups was measured by plethysmography. Groups included young adults at 102 days, mid-adults at 538 days and old adults at 815 days of age. Measurements included spontaneous breathing patterns, subdivisions of lung volume, quasistatic lung pressure-volume relationships and CO diffusing capacity. The mid-adult and old rats were larger in body size than the young rats and had larger values for breathing pattern variables and lung volumes. The mid-adult rats had lower values for functional residual capacity and residual volume and a greater quasistatic lung compliance than the young or old rats. There were no age-related differences in the position of the mid-portion of the quasistatic pressure-volume curve; however, when volumes were expressed as percentages of maximal lung volume, the curves of the older groups lay to the right of the curve for the youngest group. Although these differences suggested the possibility of a slight reduction of respiratory efficiency in the old rats, there was no clear indication of a major loss of respiratory function with age. Differences between males and females were largely related to body size, although young and mid-adult females had larger size-adjusted values for lung volumes than males. Rat lungs undergo significant changes during adulthood, due primarily to continued lung growth, but the pattern of change may be different than that of man and the degrees of the changes suggesting a possible function loss in aged subjects were less than those observed in many at an equivalent portion of the life span.

30459 **Early effects of intratracheal instillation of elastase on mortality, respiratory function, and pulmonary morphometry of F-344 rats.** Damon, E.G.; Mauderly, J.L.; Jones, R.K. (Inhalation Toxicology Research Inst., Albuquerque, NM). *Toxicology and Applied Pharmacology;* **64**: 465-475(1982). Contract AC04-76EV01013.

Rats were intratracheally instilled with purified elastase at doses ranging from 0.3 to 1.6 IU/g of body weight to induce pulmonary emphysema. In 50 rats exposed to elastase at doses ranging from 0.3 to 1.6 IU/g, the LD_{50} was approximately 1.2 IU/g. A mortality of 9% occurred in 94 rats instilled with a dose of 1.0 IU/g. Pulmonary function tests were conducted on nine surviving rats

2 to 4 weeks after instillation of elastase at doses ranging from 0.8 to 1.2 IU/g and on 20 untreated controls. The treated rats exhibited significant differences in pulmonary function similar to those observed in human emphysema. In rats treated at dose of 1.0 or 1.2 IU/g, histopathological studies showed there was an extensive loss of alveolar fine structure resulting in alveolar spaces ranging from 3 to 10 times the size of those in untreated control rats. Morphometric measurements of the mean linear intercepts of the alveolar septa confirmed these findings. Since the changes in pulmonary function and structure in rats treated with elastase at a dose of 1.0 IU/g body weight were consistent with changes observed in human patients with pulmonary emphysema, and since the mortality rate of 9% was considered acceptable, this dose was selected for use in subsequent studies requiring an animal model of emphysema.

30460 **Recruitment of antibody-forming cells in the lung after local immunization is nonspecific.** Bice, D.E.; Degen, M.A.; Harris, D.L.; Muggenburg, B.A. (Inhalation Toxicology Research Inst., Albuquerque, NM). *American Review of Respiratory Diseases;* **126**: 635-639(1982). Contract AC04-76EV01013.

The deposition of particulate antigen into the dog lung induces a large accumulation of antigen-specific-antibody-forming cells in immunized lung lobes. The results of our previous studies with dogs indicate that these cells are recruited to the immunized lung lobes from the blood. The present study was designed to determine if the recruitment of immune cells to the lung is antigen-specific, or if changes occur in the lung after immunization that allow immune cells to enter the lung nonspecifically. Dogs were immunized in the left and right cardiac lung lobes with antigenically different particulate antigens. The number of lymphoid cells producing antibody to each antigen and the concentrations of antigen-specific antibody were measured in the immunized lung lobes and in a control lung lobe at 5 through 14 days after immunization. Similar numbers of antibody-forming cells and concentrations of antibody to both antigens were found in each immunized lung lobe, regardless of which antigen was used for immunization. These results indicate that antigen exposure alters the lung to allow a non-specific recruitment of immune cells from the blood into the immunized lung lobe, regardless of antigen specificity. These data also provide further evidence that the antibody-forming cells found in the lung lavage fluid after localized immunization are produced in the thoraic lumph nodes or other systemic lymphoid tissues, rather than locally in lymphoid tissues in the deep lung.

30461 **Effects of size and growth rate on vegetative reproduction in Typha.** Grace, J.B.; Wetzel, R.G. (Michigan State Univ., Hickory Corners). *Oecologia;* **50**: 158-161(1981). Contract AC02-76EV01599.

The objective of this study was to separate the effects of plant biomass and growth rate on vegetative reproduction in two species of cat-tail. Typha latifolia and T. angustifolia. Replicate clones of both species were grown under conditions of 100%, 42%, 24%, and 9% full sunlight with harvests at 41, 70, and 91 days after shading. T. angustifolia produced most of its vegetative offspring before the first harvest and increased biomass over the remainder of the experiment by increasing the size of its ramets. In contrast, T. latifolia produced vegetative offspring gradually throughout the experiment adding new ramets only after existing clones were of mature size. As a result of these differences in the cloning process, T. angustifolia showed little correlation between vegetative reproduction and clone size while T. latifolia showed a strong correlation between vegetative reproduction and clone size at the three highest light intensities. Growth rates, average clone size and vegetative reproduction were all reduced by reductions in light intensity for both species. However, no effect of growth rate on the relationship between clone size and vegetative reproduction in T. latifolia could be detected. T. latifolia showed greater survivorship and more biomass production under 9% light than T. angustifolia indicating a greater shade tolerance.

5530 Agriculture And Food Technology

REFER ALSO TO CITATION(S) 30411, 30415, 30416, 30436

30462 **(RFP-Trans—401) Replacement of electrolytic iron by ferrite powder for the magnetic separation of clover seeds.** Tanasoiu, C.; Nicolau, P. Translated from *Studii si Cercetari de Fizica ;* **33**: No. 6, 557-563(1981). Contract AC04-76DP03533. 7p. NTIS, PC A02/MF A01. Order Number DE83010527.

Portions are illegible in microfiche products.

The comparative investigation of the physicomorphological and magnetic properties of electrolytic iron powder and soft magnetic ferrite powder with respect to use in the magnetic separation of clover seeds from dodder seeds has shown that Fe powder can be replaced advantageouly by ferrite powder in magnetic winnowing. The ferrite powder has superior magnetic properties in magnetic fields weaker than 1.5 kOe. The ferrite powder adheres better than the Fe powder to the dodder seeds. The ferrite powder is produced in Romania by a simple technology from discarded TV components. The process is inexpensive, and permits recycling of these discards. The operation of wetting the seeds during winnowing, with all its undesirable consequences, is eliminated. Existing technology and equipment need not be modified. Since the produce is stable, it is not affected by environmental factors, and can be stored for a long time under any conditions. It does not hinder germination of the seeds.

56 BIOMEDICAL SCIENCES, APPLIED STUDIES

5601 Radiation Effects

REFER ALSO TO CITATION(S) 29118, 29218, 29254, 29254, 29256, 29256, 29257, 29257, 30038, 30343, 30344, 30362, 30362, 30363, 30363, 30367, 30536, 30564

30463 **(ANL—82-65-Pt.2) Radiological and Environmental Research Division, Center for Human Radiobiology. Annual report, July 1981-June 1982.** (Argonne National Lab., IL (USA)). Nov 1982. Contract W-31-109-ENG-38. 250p. NTIS, PC A11/MF A01. Order Number DE83007660.

Separate abstracts were prepared for 12 of 33 papers, and 1 of the 2 appendices in this annual report of the Center for Human Radiobiology. The other papers were represented by abstracts only. (KRM)

30464 **(ANL—82-65-Pt.2, pp 1-20) Human health effects of radium: an epidemiologic perspective of research at Argonne National Laboratory.** Stebbings, J.H. Nov 1982. NTIS, PC A11/MF A01.

In Radiological and Environmental Research Division, Center for Human Radiobiology. Annual report, July 1981-June 1982.

The topic of health effects of radium has recently been considerably broadened by the identification of multiple myeloma as a specific outcome of bone-seeking radionuclides, and by evidence that the incidence of breast cancer may be significantly increased by radium exposure. All soft-tissue tumors are now suspect, especially leukemias. Concepts of dose-response need to be broadened to include the concept of risk factors, or, if one prefers, of susceptible subgroups. Biological factors relating to radium uptake and retention require study, as do risk factors modifying risk of both the classical tumors, osteosarcoma and nasal sinus/mastoid, and the more recently suspect soft-tissue tumors. The history, organization, and current research activities in epidemiology at Argonne National Laboratory are described, and findings of the last decade and a half reviewed. Plans for future research are briefly discussed.

30465 (ANL—82-65-Pt.2, pp 23-37) **Chronic radium intoxication: preliminary report of morphological and mineral changes in human bone.** Farnham, J.E. Nov 1982. NTIS, PC A11/MF A01.

In Radiological and Environmental Research Division, Center for Human Radiobiology. Annual report, July 1981-June 1982.

Observations are presented on bone microradiograms from 44 radium patients. The data cover three basic categories of mineral changes: (1) increase in bone mineral resorption, (2) increase in bone mineral density and (3) increase in new bone tissue formation. The data show a trend of increasing amount of mineral change in all three categories as the cumulative rads, cumulative rad-years, and amount of radium intake increase.

30466 (ANL—82-65-Pt.2, pp 39-52) **Relative activities of ^{228}Ra and ^{226}Ra in early Illinois radium dial workers.** Keane, A.T.; Lucas, H.F.; Markun, F.; Essling, M.A.; Holtzman, R.B. Nov 1982. NTIS, PC A11/MF A01.

In Radiological and Environmental Research Division, Center for Human Radiobiology. Annual report, July 1981-June 1982.

Available data were analyzed to determine the relative systemic intakes of ^{226}Ra and ^{228}Ra in Radium Dial Co. workers. The data suggested an activity ratio of ^{228}Ra to ^{226}Ra of 0.16 +- 0.08 (standard deviation) for systemic intakes occurring in the years 1921 to 1924 and negligible exposure to ^{228}Ra after 1924.

30467 (ANL—82-65-Pt.2, pp 90-92) **^{226}Ra and ^{228}Ra in drinking water.** Lucas, H.F. Nov 1982. NTIS, PC A11/MF A01.

In Radiological and Environmental Research Division, Center for Human Radiobiology. Annual report, July 1981-June 1982.

The naturally occurring concentration of ^{226}Ra in public and private water supplies has been a subject of study for many years. Both general surveys and local studies have been made. The geographical areas in the United States where water has a ^{226}Ra concentration exceeding 3 pCi/L are relatively well established, at least for public supplies. These studies have shown that wells obtaining water from the deep sandstone aquifers in the Midwest frequently have ^{226}Ra concentrations ranging from 5 to 25 pCi/L. The present study summarizes results obtained on more than 2000 samples collected between 1950 and 1978. Most of the samples were analyzed at Argonne by the emanation method; the rest were analyzed at the State Hygienic Laboratory in Iowa City, Iowa. The minimum sensitivity for ^{226}Ra was about 0.05 pCi/L at Argonne and about 0.4 pCi/L at Iowa City. The minimum sensitivity for ^{228}Ra was about 0.5 pCi/L at both laboratories.

30468 (ANL—82-65-Pt.2, pp 141-146) **Continued studies of the gastrointestinal absorption of plutonium by rodents: relationships to feeding regimen and age of animals.** Larsen, R.P.; Bhattacharyya, M.H.; Oldham, R.D.; Moretti, E.S.; Spaletto, M.I. Nov 1982. NTIS, PC A11/MF A01.

In Radiological and Environmental Research Division, Center for Human Radiobiology. Annual report, July 1981-June 1982.

In mice that are consuming food ad libitum the gastrointestinal absorption of plutonium (and its subsequent retention in liver and skeleton) has been shown to be a factor of about 10 lower than it is in the fasted anaimal. It has been found that the time required to achieve the fasted state is less than two hours for mice that are at the end of their diurnal, inactive phase and between 4 and 8 hours for mice that are 4 hours into their active phase. The absorption of plutonium appears to depend on the nature of materials in the G.I. tract, i.e., properties of the food consumed, rather than amounts present. The fractional absorption of plutonium from the G.I. tract by the rat decreases with age in the unweaned animal, from 7 x 10^{-3} on day 1 to 3 x 10^{-3} on day 19 (the latter value being the same as that for the fasted adult) and with weaning to 1 x 10^{-4} on day 29.

30469 (ANL—82-65-Pt.2, pp 147-149) **Gastrointestinal absorption and retention of neptunium by fasted and fed mice.** Larsen, R.P.; Bhattacharyya, M.H.; Oldham, R.D.; Moretti, E.S.;. Nov 1982. NTIS, PC A11/MF A01.

In Radiological and Environmental Research Division, Center for Human Radiobiology. Annual report, July 1981-June 1982.

The retention of neptunium in liver and bone subsequent to its gastrointestinal absorption has been determined in both fasted and fed mice. The values obtained for fractional retention were 3 x 10^{-3} and 1 x 10^{-4}, respectively, and are within a factor of two the same as those for plutonium in fasted and fed mice.

30470 (ANL—82-65-Pt.2, pp 151-239) **Exposure data for radium patients.** Nov 1982. NTIS, PC A11/MF A01.

In Radiological and Environmental Research Division, Center for Human Radiobiology. Annual report, July 1981-June 1982.

This appendix summarizes exposure data collected as of 31 December 1981 for 2282 radium cases under study at the Center for Human Radiobiology. It includes all persons meaasured for radium since the start of te Center in 1969 and all persons for whom we have analytic data from earlier work at the Radioactivity Center of the Massachusetts Institute of Technology, the New Jersey Radium Research Project of the New Jersey department of Health, and the Argonne Radium Studies at the Argonne National Laboratory and the Argonne Cancer Research Hospital.

30471 (ARL/TR—035) **Personal monitoring and assessment of doses received by radiation workers.** Swindon, T.N.; Morris, N.D. (Australian Radiation Lab., Melbourne). Dec 1981. 37p. NTIS (US Sales Only), PC A03/MF A01. Order Number DE83701528.

The Personal Radiation Monitoring Service operated by the Australian Radiation Laboratory is outlined and the types of monitors used for assessment of doses received by radiation workers are described. The distribution of doses received by radiation workers in different occupational categories is determined. From these distributions, the average doses received have been assessed and the maximum likely additional increase in cancer deaths in Australia as a result of occupational exposure estimated. This increase is shown to be very small. There is, however, a considerable spread of doses received by individuals within occupational groups.

30472 (BNL—32760) **Misuse of statistics in the interpretation of data on low-level radiation.** Hamilton, L.D. (Brookhaven National Lab., Upton, NY (USA)). 1982. Contract AC02-76CH00016. 47p. (CONF-8210139—1). NTIS, PC A03/MF A01. Order Number DE83010149.

From 7. symposium on statistics and the environment; Washington, DC, USA (4 Oct 1982).

Four misuses of statistics in the interpretation of data of low-level radiation are reviewed: (1) post-hoc analysis and aggregation of data leading to faulty conclusions in the reanalysis of genetic effects of the atomic bomb, and premature conclusions on the Portsmouth Naval Shipyard data; (2) inappropriate adjustment for age and ignoring differences between urban and rural areas leading to potentially spurious increase in incidence of cancer at Rocky Flats; (3) hazard of summary statistics based on ill-conditioned individual rates leading to spurious association between childhood leukemia and fallout in Utah; and (4) the danger of prematurely published preliminary work with inadequate consideration of epidemiological problems - censored data - leading to inappropriate conclusions, needless alarm at the Portsmouth Naval Shipyard, and diversion of scarce research funds.

30473 (CONF-820356—5) **Applications in genetic risk estimation of data on the induction of dominant skeletal mutations in mice.** Selby, P.B. (Oak Ridge National Lab., TN (USA)). 1982. Contract W-7405-ENG-26. 39p. NTIS, PC A03. Order Number DE83009858.

From Conference of the National Institute of Environmental Health Sciences; Research Triangle Park, NC, USA (28 Mar 1982).

Paper copy only, copy does not permit microfiche production.

Studies on the induction of dominant skeleton mutations and of dominant cataract mutations provide means of estimating genetic hazard to humans from radiation. The breeding-test method of studying the induction of dominant skeletal mutations is slow and cumbersome. In an attempt to devise a more rapid method, three

non-breeding-test methods have been developed which are likely to have wider application in mutagenicity testing. (ACR)

30474 **(DOE/ER/60038—T1) Screening human populations for chromosome damage. Progress report, March 1982-November 1982.** Norman, A. (California Univ., Los Angeles (USA). Lab. of Biomedical and Environmental Sciences). 1982. Contract AT03-82ER60038. 7p. NTIS, PC A02/MF A01. Order Number DE83010042.

Portions are illegible in microfiche products.

The micronuclear counts in 73 relatively young and healthy patients obtained in previous studies were examined. The natural logarithm of the micronuclear counts (LMNC) was approximately normally distributed so we have tested the effects of age, sex, and medical x-ray exposure on the counts. The results show a clear dependence of micronuclear counts on age, and demonstrate that studies of chromosome damage in radiation workers or in other populations exposed to radiation may be misinterpreted if the effects of age and medical x-ray examinations are not controlled. The results also show that the variability in LNMC among the individuals examined cannot be accounted for totally by the factors of age, sex, or medical x-rays. There are at least two other important sources of variation: counting statistics and degree of lymphocyte proliferation. A single set of harlequin stained cells may be sufficient for estimating micronuclear yields, the degree of lymphocyte proliferation, and possibly the frequency of chromosome aberrations. These results point to the usefulness of the micronucleus assay for screening human populations for chromosome damage.

30475 **(GSF-B—1030) Biological indicators of radiation effects in man.** Bauchinger, M. (Gesellschaft fuer Strahlen- und Umweltforschung m.b.H. Muenchen, Neuherberg (Germany, F.R.)). 1979. 26p. Available from Fachinformationszentrum Energie, Physik, Mathematik, Karlsruhe (Germany, F.R.).

From International meeting of investigators on biological indicators of radiation effects in man; Neuherberg (Germany, F.R.) (10 - 11 Dec 1979).

The purpose of the meeting was to review existing knowledge of the biological indicators and to consider their practical significance after accidental, occupational and medical exposure. In addition, in vitro dose-effect relationships, the statistical treatment of data and the applicaton of automated procedures for cell finding and analysis were discussed together with the current status of research on the Japanese A-bomb survivors. A lot of conclusions and recommendations were made.

30476 (GSF-B—1030, pp 9) **Improved quantitation of chromosome aberration estimates using the FPG technique.** Scott, D. 1979. Available from Fachinformationszentrum Energie, Physik, Mathematik, Karlsruhe (Germany, F.R.).

From International meeting of investigators on biological indicators of radiation effects in man; Neuherberg (Germany, F.R.) (10 - 11 Dec 1979).

Published in summary form only.

30477 (GSF-B—1030, pp 10) **Age dependence of chromosome aberration induction.** Lloyd, D. 1979. Available from Fachinformationszentrum Energie, Physik, Mathematik, Karlsruhe (Germany, F.R.).

From International meeting of investigators on biological indicators of radiation effects in man; Neuherberg (Germany, F.R.) (10 - 11 Dec 1979).

Published in summary form only.

30478 (GSF-B—1030, pp 11) **Applicability of different aberration types for cytogenetic dosimetry.** Schmid, E. 1979. Available from Fachinformationszentrum Energie, Physik, Mathematik, Karlsruhe (Germany, F.R.).

From International meeting of investigators on biological indicators of radiation effects in man; Neuherberg (Germany, F.R.) (10 - 11 Dec 1979).

Published in summary form only.

30479 (GSF-B—1030, pp 12) **Analysis of dose-response relations after X-irradiation of different human lymphocyte fractions.** Dresp, J. 1979. Available from Fachinformationszentrum Energie, Physik, Mathematik, Karlsruhe (Germany, F.R.).

From International meeting of investigators on biological indicators of radiation effects in man; Neuherberg (Germany, F.R.) (10 - 11 Dec 1979).

Published in summary form only.

30480 (GSF-B—1030, pp 13) **Chromosome aberrations in peripheral blood lymphocytes after controlled partial gamma-ray exposure in rabbits.** Liniecki, J.; Bajerska, A. 1979. Available from Fachinformationszentrum Energie, Physik, Mathematik, Karlsruhe (Germany, F.R.).

From International meeting of investigators on biological indicators of radiation effects in man; Neuherberg (Germany, F.R.) (10 - 11 Dec 1979).

Published in summary form only.

30481 (GSF-B—1030, pp 14) **Cytogenetic study of A-bomb survivors of Hiroshima and Nagasaki.** Awa, A.A. 1979. Available from Fachinformationszentrum Energie, Physik, Mathematik, Karlsruhe (Germany, F.R.).

From International meeting of investigators on biological indicators of radiation effects in man; Neuherberg (Germany, F.R.) (10 - 11 Dec 1979).

Published in summary form only.

30482 (GSF-B—1030, pp 15) **Frequency of chromosome aberrations found in peripheral blood lymphocytes of men servicing nuclear powered submarines.** Buckton, K.E. 1979. Available from Fachinformationszentrum Energie, Physik, Mathematik, Karlsruhe (Germany, F.R.).

From International meeting of investigators on biological indicators of radiation effects in man; Neuherberg (Germany, F.R.) (10 - 11 Dec 1979).

Published in summary form only.

30483 (GSF-B—1030, pp 16) **Chromosome aberrations in lymphocytes of workers of nuclear power plants.** Bauchinger, M. 1979. Available from Fachinformationszentrum Energie, Physik, Mathematik, Karlsruhe (Germany, F.R.).

From International meeting of investigators on biological indicators of radiation effects in man; Neuherberg (Germany, F.R.) (10 - 11 Dec 1979).

Published in summary form only.

30484 (GSF-B—1030, pp 17) **Chromosome aberrations in women treated by gamma-rays for breast carcinoma.** Antoine, J.L.; Leonard, A.; Gerber, G.B.; Richard, F.; Wambersie, A. 1979. Available from Fachinformationszentrum Energie, Physik, Mathematik, Karlsruhe (Germany, F.R.).

From International meeting of investigators on biological indicators of radiation effects in man; Neuherberg (Germany, F.R.) (10 - 11 Dec 1979).

Published in summary form only.

30485 (GSF-B—1030, pp 18) **Chromosome dosimetry valorization by hematological data.** Le Go, R.; Doloy, M.T.; Malarbet, J.L.; Veyrat, M. 1979. Available from Fachinformationszentrum Energie, Physik, Mathematik, Karlsruhe (Germany, F.R.).

From International meeting of investigators on biological indicators of radiation effects in man; Neuherberg (Germany, F.R.) (10 - 11 Dec 1979).

Published in summary form only.

30486 (GSF-B—1030, pp 19) **Metaphase finding, features for identification and their detection in image and diffraction pattern.** Hutzler, P.J.S. 1979. Available from Fachinformationszentrum Energie, Physik, Mathematik, Karlsruhe (Germany, F.R.).

From International meeting of investigators on biological indicators of radiation effects in man; Neuherberg (Germany, F.R.) (10 - 11 Dec 1979).
Published in summary form only.

30487 (GSF-B—1030, pp 20) **Statistical aspects of cytogenetic dosimetry.** Merkle, W.; Paretzke, H.G.; Eisfeld, K.; Mederer, E. 1979. Available from Fachinformationszentrum Energie, Physik, Mathematik, Karlsruhe (Germany, F.R.).
From International meeting of investigators on biological indicators of radiation effects in man; Neuherberg (Germany, F.R.) (10 - 11 Dec 1979).
Published in summary form only.

30488 (GSF-B—1030, pp 21) **Applicability of micronucleus and sperm abnormality assays in cytogenetic dosimetry.** Heddle, J.A. 1979. Available from Fachinformationszentrum Energie, Physik, Mathematik, Karlsruhe (Germany, F.R.).
From International meeting of investigators on biological indicators of radiation effects in man; Neuherberg (Germany, F.R.) (10 - 11 Dec 1979).
Published in summary form only.

30489 (GSF-B—1030, pp 22) **Blood stem cells as an indicator of radiation exposure.** Fliedner, T.M.; Nothdurft, W. 1979. Available from Fachinformationszentrum Energie, Physik, Mathematik, Karlsruhe (Germany, F.R.).
From International meeting of investigators on biological indicators of radiation effects in man; Neuherberg (Germany, F.R.) (10 - 11 Dec 1979).
Published in summary form only.

30490 (GSF-B—1030, pp 23) **Deoxyribonucleoside-urea and some immunological changes in postirradiation effects.** Dienstbier, Z. 1979. Available from Fachinformationszentrum Energie, Physik, Mathematik, Karlsruhe (Germany, F.R.).
From International meeting of investigators on biological indicators of radiation effects in man; Neuherberg (Germany, F.R.) (10 - 11 Dec 1979).
Published in summary form only.

30491 (GSF-B—1030, pp 24) **Metabolism of amino acids after irradiation with respect to biological dosimetry.** Streffer, C. 1979. Available from Fachinformationszentrum Energie, Physik, Mathematik, Karlsruhe (Germany, F.R.).
From International meeting of investigators on biological indicators of radiation effects in man; Neuherberg (Germany, F.R.) (10 - 11 Dec 1979).
Published in summary form only.

30492 (JAERI-M—9794) **Immobilization of yeast cells with hydrophilic carrier by radiation-induced polymerization.** Fujimura, T.; Kaetsu, I. (Japan Atomic Energy Research Inst., Tokyo). Nov 1981. 18p. (In Japanese). NTIS (US Sales Only), PC A02/MF A01. Order Number DE83701541.
Radiation-induced polymerization method was applied to the immobilization of yeast cells. The effects of irradiation, cooling and monomer, which are necessary for polymerization, were recovered completely by subsequent aerobical incubation of yeast cells. The ethanol productivity in immobilized yeast cells increased with the increase of aerobical incubation period. The growth of yeast cells in immobilized yeast cells was indicated. The maximum ethanol productivity in immobilized yeast cell system was around three times as much as that in free yeast cell system.

30493 (LA—9479-PR, pp 41-42) **Pion radiobiology.** Raju, M.R.; Butler, J.L.; Carpenter, S.G.; DiCello, J.F.; Pierotti, D.; Smith, A.R.; Tokita, N. Oct 1982. NTIS, PC A08/MF A01.
In Los Alamos Life Sciences Division's biomedical and environmental research programs. Progress report, January-December 1981.
Physical characteristics of negative pions depend on the pion stopping volume. Therefore, the biological effects of pions may be affected by the width of the Bragg peak, range modulations, and the size of the treatment volume. As a part of pretherapeutic radiobiology, attempts were made to provide: biological dosimetry to verify that range-shifter functions used to spread peaks are optimal for therapy in producing uniform cell killing across the region of interest; and data on cell killing by pion beams of different peak widths or sizes. The results of Phase I studies using V79 cells suspended in gelatin indicated: no significant differences in cell killing between pion beams of different ranges but of the same peak width; no significant differences between pion beams of different sizes but of the same peak width; a slight decrease in biological effectiveness with increasing peak width; and satisfactory range-modulation functions to produce uniform cell killing for intermediate-range pion beams.

30494 (LA—9479-PR, pp 42-43) **Cytometric analysis of irradiation damaged chromosomes.** Wilder, M.E.; Raju, M.R. Oct 1982. NTIS, PC A08/MF A01.
In Los Alamos Life Sciences Division's biomedical and environmental research programs. Progress report, January-December 1981.
Irradiation of cells in interphase results in dose-dependent damage to DNA which is discernable by flow-cytometric analysis of chromosomes. The quantity (and possibly the quality) of chromosomal changes is different in survival-matched doses of x and α irradiation. It may, therefore, be possible to use these methods for analysis of dose and type of exposure in unknown cases.

30495 **(PB—83-156588) Ionizing radiation 584 - student manual.** (National Inst. for Occupational Safety and Health, Cincinnati, OH (USA). Div. of Training and Manpower Development). Aug 1981. 854p. NTIS, PC A99/MF A01.
A course designed to introduce professional health personnel to radiological health is outlined. Topics covered in the course include radiation sources, detection instruments, and radiation control methods. Use of radiation detection instruments and radiation survey techniques are stressed. Course objectives are to enable the student to identify a radiation source, select the proper instrument for evaluating the source and recommend the appropriate control methods for personnel radiation protection.

30496 **(PNL-SA—11049) Current concepts in lung dosimetry. Proceedings of a special workshop.** Fisher, D.R. (ed.). (Pacific Northwest Lab., Richland, WA (USA)). Feb 1983. Contract AC06-76RL01830. 199p. (CONF-820492—Pt.1). NTIS, PC A09/MF A01. Order Number DE83007285.
From 30. annual meeting of the Radiation Research Society; Salt Lake City, UT, USA (18 Apr 1982).
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The proceedings of the first special workshop on Lung Dosimetry include the presentation of many new concepts and the reassessment of traditional ideas in lung dosimetry and risk evaluation. Separate abstracts were prepared for the 21 papers in the proceedings. (KRM)

30497 (PNL-SA—11049, pp 3-17) **Lung dose and lung cancer risk by inhalation of radon daughters.** Jacobi, W. (Institut fuer Strahlenschutz, Muenchen-Neuherberg, Germany). Feb 1983. NTIS, PC A09/MF A01.
From 30. annual meeting of the Radiation Research Society; Salt Lake City, UT, USA (18 Apr 1982).
The inhalation of short-lived radon daughters constitutes the most important occupational radiation exposure in mines, particularly in uranium mines. Among some groups of miners exposed in the past to relatively high radon levels, an excess lung cancer incidence has been observed. In addition to this occupational hazard, the observed radon levels in domestic houses indicate that the inhalation of short-lived radon daughters seems to be the most important component of the radiation exposure of the population from natural sources. For the quantification and judgment of the radiological impact by inhalation of radon daughters in mines as well as in houses, it is necessary to estimate the relationships between the inhaled activity or potential alpha (α) energy of these radionuclides, the dose to target tissues in the lung, and the possible associated lung cancer (LC) risk. It is the purpose of this paper to give a con-

densed review of our present knowledge in this field and to indicate the main gaps and uncertainties where future research seems necessary.

30498 (PNL-SA—11049, pp 18-28) **Dosimetry of internally deposited radionuclides in lung and its usefulness in predicting biological effects.** Diel, J.H.; Guilmette, R.A.; Hahn, F.F.; Lundgren, D.L.; Mewhinney, J.A.; Muggenburg, B.A.; Snipes, M.B.; Boecker, B.B.; McClellan, R.O. (Inhalation Toxicology Research Inst., Albuquerque, NM). Feb 1983. NTIS, PC A09/MF A01. Contract AC04-76EV01013.

From 30. annual meeting of the Radiation Research Society; Salt Lake City, UT, USA (18 Apr 1982).

Dosimetry of inhaled radionuclides deposited in lung is being studied to improve our understanding of the macroscopic and microscopic distributions of radiation dose. The spatial distribution of dose in lung and its effect was studied using monodisperse aerosols and radionuclides of different specific activities. The study of the influence of temporal distribution of dose used radionuclides with different physical half-lives. Movement of particles in the lung, the clearance of materials from the lung and the resulting changes in dose to the lung were studied using autoradiography. Resulting patterns of dose and radionuclide distribution in the lung were described statistically. On the basis of the results, we conclude that dosimetry of internally deposited radionuclides in the lung, to be useful, must include study of the spatial distribution, temporal distribution and radiation type.

30499 (PNL-SA—11049, pp 29-36) **Search of the relevant lung dose.** Fisher, D.R. (Pacific Northwest Lab., Richland, WA). Feb 1983. NTIS, PC A09/MF A01.

From 30. annual meeting of the Radiation Research Society; Salt Lake City, UT, USA (18 Apr 1982).

Researchers have traditionally been inconsistent in their methods of determining and reporting dose to the lung form inhaled radionuclides-a situation which has led to difficulties in later comparing results and deriving dose-response relationships. The dose quantities which at present are most generally assumed to be related to risk of stochastic radiation effects (such as lung cancer) are (1) mean dose equivalent to the bronchial epithelium basal cell layer for radon daughters, and (2) mean dose equivalent to the whole lung (including tracheobronchial lymph nodes) for all other radionuclides. The average radiation dose is calculated by assuming that the energy is homogeneously imparted to the entire tissue mass. However, the actual dose received by a cell which becomes transformed or tumorigenic is likely to be very much different than the smear dose to the entire organ. This realization has led to further study of stochastic energy deposition processes in single cells or cell nuclei from internal emitters. The end product of the stochastic approach to dosimetry, sometimes called microdosimetry, is a probability density in specific energy. For alpha-emitting radionuclides in the lung, a concept that may be more important than dose is the probability that a cell is hit by an alpha particle.

30500 (PNL-SA—11049, pp 37-43) **Dosimetric concepts for inhaled radon decay products in the human lung.** Hofmann, W. (Univ. of Salzburg, Austria). Feb 1983. NTIS, PC A09/MF A01.

From 30. annual meeting of the Radiation Research Society; Salt Lake City, UT, USA (18 Apr 1982).

The primary objective of lung dosimetry is to provide a physical basis in terms of radiation doses for establishing the relationship between airborne radon decay products and lung cancer induction as the most important biological endpoint. In order to accomplish this goal, several dosimetric approaches have been developed which are based on reasonable approximations of the anatomical structure of the respiratory tract, of clearance mechanisms for particles deposited, and of energy deposition at the cellular level. Usually lung cancer risk is correlated with the mean radiation dose to the stem cells in the bronchial epithelium. A different approach is presented here through the application of stochastic models which allow for the biological variability inherent in all anatomical and physiological parameters. Thus, the specific energy distribution in cells or cell nuclei and the number of sensitive targets hit are more appropriate quantities for the interpretation of lung cancer incidence. The relevance of dosimetric approaches at the cellular level is, however, intimately connected with models describing the transformation towards malignancy, and further improvements of lung dosimetry can only be achieved by a more profound insight into the basic biological mechanisms involved in radiation-induced carcinogenesis.

30501 (PNL-SA—11049, pp 49-58) **Spatial distribution of inhaled particles in rodent lungs.** Hodgson, A.; Bailey, M.R.; Birchall, A.; Murfitt, A.J. (National Radiological Protection Board, Chilton, England). Feb 1983. NTIS, PC A09/MF A01.

From 30. annual meeting of the Radiation Research Society; Salt Lake City, UT, USA (18 Apr 1982).

The spatial distribution of particles in the lungs is being studied to improve understanding of particle clearance mechanisms and to determine the distribution of doses to lung tissues from inhaled radioactive particles. In a pilot experiment 15 rats and 15 hamsters inhaled 1.2 μm diameter monodisperse fused aluminosilicate particles labelled with ^{85}Sr. Total body retention in each animal was followed by external gamma counting, and groups were sacrificed at times up to 200 days for distribution measurements. Particles are located in lung sections by Auger electron autoradiography. Positions of particles, ciliated airways and the lung periphery in each section are obtained using a semi-automatic image analyzer interfaced to a microcomputer on which data analyses are performed. Aggregation coefficients are calculated to assess the significance of the difference between the observed spatial distributions and random distributions. Particle concentrations as functions of distance from airways and the lung periphery will be combined with individual retention curves to assess particle retention in different parts of the pulmonary region. Clearance at different rates from different sites is a possible explanation for the phases observed in the pulmonary retention curves, not only of rodents, but also of man. The spatial and temporal distribution of particles in the lung, combined with the dose distribution around individual particles, will enable dose distributions to specific cell types in the bronchial epithelium and alveoli to be determined.

30502 (PNL-SA—11049, pp 59-65) **Dosimetry and response in rat pulmonary epithelium following inhalation of $^{239}PuO_2$.** Rhoads, K.; Mahaffey, J.A.; Sanders, C.L. (Pacific Northwest Lab., Richland, WA). Feb 1983. NTIS, PC A09/MF A01.

From 30. annual meeting of the Radiation Research Society; Salt Lake City, UT, USA (18 Apr 1982).

The distribution of inhaled $^{239}PuO_2$ and pathologic changes have been studied in the lung of rats. The clearance of inhaled ^{237} $^{239}PuO_2$ from the lung is a function of the amount of deposited Pu with a decrease in early alveolar clearance with increasing lung burden. With increasing time post-exposure there is a greater concentration of PuO_2 and an increased aggregation of PuO_2 particles in subpleural regions of the lung. Fibrotic and metaplastic lesions in the lung were usually focal, being found in subpleural regions associated with aggregates of PuO_2. An average of 12 +- 6 percent of the lung volume was fibrotic at 530 days after an initial alveolar deposition of 180 nCi ^{239}Pu. Lung tumors occupied 4 +- 6 percent and epithelial metaplasias less than 1 percent of the lung volume at this time. Cell proliferation as assayed by tritiated thymidine autoradiography was greater in fibrotic, metaplastic and neoplastic regions than in areas of normal alveolar-bronchiolar epithelium. Turnover times ranged from about 6 days for fibrotic lesions to 1 to 3 days for metaplastic and neoplastic lesions. The lung tumor doubling times were 57 to 116 days due to tumor cell necrosis and other factors that limit tumor cell survival. Cell proliferation rates for adenomatous metaplasia were similar to those for adenocarcinoma while those for squamous cell metaplasia were similar to those for squamous cell carcinoma. Squamous lesions exhibited a more rapid growth than did adenomatous lesions.

30503 (PNL-SA—11049, pp 66-72) **Retention of various types and sizes of particle in the large airways of the rat: implications for assessing the risk of lung cancer.** Patrick, G. (MRC Radiobiology Unit, Harwell, England). Feb 1983. NTIS, PC A09/MF A01.

From 30. annual meeting of the Radiation Research Society; Salt Lake City, UT, USA (18 Apr 1982).

Clearance kinetics and retention in rat trachea have been compared for fused aluminosilicate particles (FAP) of count media diameters 1.1 and 5.7 μm, and for 1.0 μm $BaSO_4$ particles. A 2.5 μl suspension was deposited in the distal trachea of conscious rats. In each case there was an initial fast phase of clearance from the deposition zone, removing 88 percent of 1.1 μm FAP, 73 percent of 5.7 μm FAP, and 82 percent of $BaSO_4$. The remainder was cleared more slowly with half-times of 24 hours, 17 hours, and 15 hours, respectively. Retention in the tracheal wall after 7 days was 0.45 percent, 0.75 percent and 0.83 percent, respectively. The 5.7 μm FAP particles retained after 7 days were shown by autoradiography to be located either in the epithelium of the trachea or beneath the epithelium in the lamina propria. Electron microscopic evidence suggested that the particles were within macrophages. These and previous results demonstrate similar retention in the airways for different kinds and sizes of particle. The particles are retained in or beneath the airway epithelium, mostly within 440 μm of the basal cells. Thus, or inhaled insoluble α-emitters, a small proportion of particles can be retained at sites where they may constitute the greatest risk of inducing bronchogenic lung cancer.

30504 (PNL-SA—11049, pp 73-79) **Retention of relatively insoluble particles inhaled by dogs, rats and mice.** Snipes, M.B. (Inhalation Toxicology Research Inst., Albuquerque, NM). Feb 1983. NTIS, PC A09/MF A01. Contract AC04-76EV01013.

From 30. annual meeting of the Radiation Research Society; Salt Lake City, UT, USA (18 Apr 1982).

Dogs, rats and mice were exposed briefly by inhalation to one of three monodisperse aerosols 0.7 μm, 1.5 or 2.8 μm activity median aerodynamic diameter (AMAD), or a polydisperse aerosol of ^{134}Cs-labeled fused aluminosilicate particles. Tissues and excreta were collected to 850 days after exposure to determine how these differences in particle size would influence the fate of the inhaled particles. Emphasis was placed on the long-term retained burden of particles deposited by inhalation in the respiratory tract. A simulation model was developed for each species and each aerosol. With the exception of the 2.8 μm AMAD aerosol which cleared principally by mechanical processes, solubilization was the dominant lung clearance process in dog. Mechanical clearance was the dominant clearance process for rats and mice for particles with dissolution half-times greater than a few hundred days. While the dissolution rate was influenced by particle size, the mechanical clearance rate for the particles was independent of particle size for all three animal species. Clearance from lung to lung-associated lymph nodes (LALN) occurred at a constant rate of 0.0002 day^{-1} for dogs. Clearance of particles to LALN in rats and mice occurred with a pattern which could be simulated as a process which was significant for only a few days after inhalation exposure. For all three species, the upper respiratory tract tenaciously retained a small portion of the initially deposited particles.

30505 (PNL-SA—11049, pp 80-82) **Long term lung retention after inhalation of cobalt-oxide and cobalt-nitrate aerosols.** Kreyling, W.G.; Ferron, G.A.; Haider, B.; Jacobi, W. (Institut fuer Strahlenschutz, Muenchen-Neuherberg, Germany). Feb 1983. NTIS, PC A09/MF A01.

From 30. annual meeting of the Radiation Research Society; Salt Lake City, UT, USA (18 Apr 1982).

After a single inhalation of the aerosol the long-term lung retention has been measured up to four years. The retained material is determined by its ^{57}Co radioactivity using a gamma camera. Additionally the major lung clearance pathways are estimated by excretion analysis. The dogs have inhaled either monodisperse or bimodal distributed cobaltoxide aerosols in nine experiments with two dogs each. In another experiment dogs have inhaled a cobaltnitrate aerosol. The retention varies with the different aerosols but the agreement of the retention data of dogs inhaling the same aerosol is very good. The retention can be described by a sum of three exponential terms. For all experiments (even with cobalt-nitrate) which are running more than two years the long-term retention is best described with a biological half-life time (BHLT) of 400 days. The long-term fraction of the initial lung burden is about 10 percent. The short term is due to the mucociliary clearance of the tracheobronchial tree. Its fraction and BHLT correspond to the ICRP data. The intermediate phase depends on the solubility of the particles in the lung. The solubility of cobaltoxide particles in the lung depends on their size and chemical structure.

30506 (PNL-SA—11049, pp 83-89) **Effects of repeated inhalation exposure of rats to aerosols of $^{144}CeO_2$: a preliminary report.** Lundgren, D.L.; Hahn, F.F.; McClellan, R.O. (Inhalation Toxicology Research Inst., Albuquerque, NM). Feb 1983. NTIS, PC A09/MF A01.

From 30. annual meeting of the Radiation Research Society; Salt Lake City, UT, USA (18 Apr 1982).

Male and female 84-day-old Fischer-344 rats were repeatedly exposed to aerosols of $^{144}CeO_2$ to reestablish desired lung burdens of 0.04, 0.2, 1.0 or 5.0 μCi of ^{144}Ce every 60 days for one year (7 exposures). Other 84-day-old rats were exposed once to achieve desired initial lung burdens of 0.04, 0.2, 1.0 or 5.0 μCi ^{144}Ce. Older rats were exposed once to achieve desired long burdens of 1.0 or 5.0 μCi when 460 days of age-the age of the rats when repeatedly exposed for the last time. Control rats were either unexposed, sham-exposed once or repeatedly, or exposed to aerosols of particles containing stable CeO_2 once or repeatedly. The median survival time and cumulative percent survival curves were significantly decreased only in the rats repeatedly exposed to restablish a 5.0 μCi lung burden. The incidence of primary lung tumors appeared to be related to the cumulative beta radiation dose rate rather than the rate at which it was accumulated. This observation is consistent with the results from similar studies in mice and Syrian hamsters.

30507 (PNL-SA—11049, pp 90-94) **Microdosimetry of alpha-irradiated lung.** Simmons, J.A.; Richards, S.R. (Polytechnic of Central London, England). Feb 1983. NTIS, PC A09/MF A01.

From 30. annual meeting of the Radiation Research Society; Salt Lake City, UT, USA (18 Apr 1982).

This investigation attempts to calculate the dose and effects arising from the alpha-irradiaton of deep lung tissue. An image analyzer has been used to view thin sections of lung tissue which have been fixed at 10 cm inflation pressure and then stained. A $^{239}PuO_2$ particle was assumed to be trapped in an alveolar sac and the hypothetical alpha-particles emitted from it followed through air and tissue. This approach allowed the effects of the real structure to be examined in detail. It is shown that there is a fair comparison with results previously obtained with hamster lung, and that the approximation of a uniform, structureless lung is a poor one. Some of the results have tentatively been extrapolated to human lung.

30508 (PNL-SA—11049, pp 95-103) **Relevance of animal models for radionuclide inhalation in man.** Daschil, F.; Hofmann, W. (Univ. of Salzburg, Austria). Feb 1983. NTIS, PC A09/MF A01.

From 30. annual meeting of the Radiation Research Society; Salt Lake City, UT, USA (18 Apr 1982).

Our knowledge of biological effects caused by inhaled radioactive nuclides in the human lung is largely based on experiments with different animal species. For a correct interpretation of these results and their extrapolation to man, differences in anatomical and physiological parameters and their effect on lung dose distributions have to be considered. Under the assumption of the applicability of the Weibel lung model to all animal species, appropriate scaling factors for morphological and physiological parameters have been derived from experimental data available at this time. Due to these interspecific differences, initial deposition, as well as subsequent redistribution of nuclides deposited by transport mechanisms, shows a different pattern throughout the respiratory tract as compared to the human lung. The mathematical description of these processes in single generations by time-dependent differential equations permits the simulation of the temporal behavior of radionuclide activities on airway surfaces, which is of particular significance in short-term inhalation studies. Together with characteristic basal cell depths in the bronchial epithelium, radiation doses have been computed for a variety of experimental inhalation conditions and animal models.

30509 (PNL-SA—11049, pp 104-115) **Pulmonary retention of insoluble particles in man.** Bailey, M.R.; Fry, F.A. (National Radiological Protection Board, Chilton, England). Feb 1983. NTIS, PC A09/MF A01.

From 30. annual meeting of the Radiation Research Society; Salt Lake City, UT, USA (18 Apr 1982).

Twelve subjects inhaled monodisperse 1 μm and 4 μm diameter fused aluminosilicate particles (FAP) labelled with ^{85}Sr and

^{90}Y, respectively. Retention was followed for a year. Approximately 8 percent of the initial lung deposit of 1 μm particles and 40 percent of 4 μm particles cleared within 6 days. At 350 days after inhalation, retention of the initial pulmonary deposit was 46 +- 11 percent (anti x- +- SD) for the 1 μm particles and 54 +- 11 percent for the 4 μm particles. Lung dissolution rates were estimated to be 8 x 10^{-4} d^{-1} and 3 x 10^{-4} d^{-1} for the 1 μm and 4 μm particles, repsectively. The remainder cleared with a half-time of about 700 days. Pulmonary clearance of FAP in man was similar to that reported for dogs, but was much slower than that in rodents. The dissolution rate of FAP in the lungs, however, showed no great difference between man, dog and rat. It is proposed that assessments of doses to man, from inhalation of materials for which adequate human lung clearance data are not available, be based on measurement of the dissolution rates of the materials in the lungs of animals, and on the mechanical clearance of particles from the human lung measured in this experiment.

30510 (PNL-SA—11049, pp 116-126) **Modifications to the ICRP model for inhaled plutonium oxide based on the observed lung clearance and urinary excretion.** Ramsden, D. (Atomic Energy Establishment, Winfrith, England). Feb 1983. NTIS, PC A09/MF A01.

From 30. annual meeting of the Radiation Research Society; Salt Lake City, UT, USA (18 Apr 1982).

Patterns of lung clearance following the accidental intake of plutonium oxide have been previously reported by this laboratory. The observed patterns differ from those postulated in the ICRP Lung Model. This paper will report on work, partially funded by the EEC, aimed at modifying the ICRP Model in order to match observed clearance patterns. The models are extended so as to predict urinary excretion levels of plutonium following inhalation. Comparisons are made between the urine levels predicted by these models and the monitoring results obtained over some fifteen years experience. The practical use of such models in rapidly establishing the probable effective dose equivalents following suspected inhalation incidents is discussed.

30511 (PNL-SA—11049, pp 127-137) **Measurements of the microdistributions of α-active nuclei in the human lung.** Henshaw, D.L.; Fews, A.P. (Univ. of Bristol, England). Feb 1983. NTIS, PC A09/MF A01.

From 30. annual meeting of the Radiation Research Society; Salt Lake City, UT, USA (18 Apr 1982).

Using new techniques for alpha-autoradiography developed in this laboratory the authors are currently engaged in a major study of the microdistribution of α-active nuclei in the human lung. The technique is based on the highly sensitive plastic nuclear track detector CR-39. Samples of tissue obtained at autopsy are dissected and mounted against CR-39 and stored deep frozen for 3 to 30 months. Alpha track positions on the plastic can be accurately correlated with tissue features, and activities down to ~ 10^{-15} Ci g^{-1} can be detected. The corresponding track measurements provide: (1) a local determination of the ^{222}Rn diffusion coefficient in tissue which enables the separate activities of ^{222}Rn + daughter activity to be separately determined and (2) determination of the abundance values of α-active nuclides present. The authors seek case histories representing a wide spectrum of lung burden, including the population in general, smokers, miners, and workers in the nuclear industry. In each lung the activity has been studied in the tracheobronchial tree, lung parenchyma and the lymph nodes. Data will be presented summarizing our current results.

30512 (PNL-SA—11049, pp 139-143) **Assessment of lung dose from radon daughters in the mine atmosphere.** Vohra, K.G.; Subba Ramu, M.C. (Bhabha Atomic Research Center, Bombay, India). Feb 1983. NTIS, PC A09/MF A01.

From 30. annual meeting of the Radiation Research Society; Salt Lake City, UT, USA (18 Apr 1982).

Assessment of dose to the tracheo-bronchial region of the lung due to breathing of air containing radon daughter products has become highly significant ever since the epidemiological studies have shown that the uranium mine workers are likely to develop cancer in this region of the lung. Radiation dose to the critical region of the lung of the uranium mine worker can be estimated with a knowledge of the deposition and retention rates. Both the unattached and attached fractions of radon daughters in the mine atmosphere are taken into consideration. The percentages of the total activity deposited in the tracheo-bronchial region as unattached and attached fractions would be 12 and 5.2 respectively for nasal breathing. However, the alpha-energy absorption due to the deposition of the attached fraction works out to be 2.4 times that due to the unattached fraction. Using the above data on realistic conditions of the mine atmosphere and appropriate values for the regional masses of the tracheo-bronchial tissue irradiated by the two alpha energies, 6 MeV (Ra-A) and 7.69 MeV (Ra-C') from the deposited radon daughters the authors have estimated the activity to dose conversion factor for radon daughter inhalation to be 15 μgray per Bq. hr. per liter. The implications of this factor in the dose response relationship evaluated in terms of dose-equivalent limits by ICRP are discussed in some detail.

30513 (PNL-SA—11049, pp 144-151) **Properties of radon progeny aerosols in mainstream cigarette smoke and the alpha dose at segmental bifurcations of smokers.** Martell, E.A.; Sweder, K.S. (National Center for Atmospheric Research, Boulder, CO). Feb 1983. NTIS, PC A09/MF A01.

From 30. annual meeting of the Radiation Research Society; Salt Lake City, UT, USA (18 Apr 1982).

Size distributions of radon progeny aerosols were determined by passing radon progeny-tagged smoke particles and ^{212}Pb-tagged smoke particles through burning cigarettes, collecting the mainstream smoke particles on a multistage cascade impactor, and determining the radioactivity on each impactor stage by low-level β^- counting. The Activity Median Aerodynamic Diameter (AMAD) of radon progeny in mainstream smoke varies inversely with the flow-rate of air through the burning cigarette, with an AMAD of ~ 1.5 μm at a puff velocity of 18 cm^3 s^{-1} (about average for cigarette smokers). Particles of this size are selectively deposited in hot spots at the carina of segmental bifurcations to a remarkable degree. Experimental evidence on the solubility, persistence, and distribution of ^{210}Pb, ^{212}Pb-, and ^{214}Pb-enriched particles deposited on the bronchial epithelium of cigarette smokers is discussed. The excess alpha radiation dose at the segmental bifurcations of cigarette smokers is estimated for a smoking rate of one pack per day and for average indoor radon and thoron progeny levels. The smoker is subjected to alpha radiation in the bronchial epithelium fom three sources: (1) from indoor radon and thoron progeny inhaled between cigarettes; (2) from ^{214}Po, ^{212}Po and ^{212}Bi in large, mainstream smoke particles, and (3) from ^{210}Po which grows into ^{210}Pb-enriched particles which persist at bifurcations. It is estimated that the combined alpha dose in hot spots at bifurcations of smokers who die of lung cancer may approach or exceed 100 rads (2000 rem).

30514 (PNL-SA—11049, pp 152-156) **Epidemiologic approach to determining the REM dose to bronchial epithelium from radon daughter exposures in man.** Radford, E.P. (Univ. of Pittsburgh, PA). Feb 1983. NTIS, PC A09/MF A01.

From 30. annual meeting of the Radiation Research Society; Salt Lake City, UT, USA (18 Apr 1982).

Dosimetric evaluation of exposures to the bronchial epithelial stem cells from inhalation of alpha emitters is complex and the number of assumptions required leads to substantial uncertainty. Moreover, it is evident that many factors such as variable breathing patterns will modify the results. An empirical approach to determining the rem dose biologically effective in producing bronchial cancer by inhalation of radon daughters is possible by comparison of cumulative exposure in terms of Working Level Months with the dose of penetrating low-LET radiation to produce the same bronchial cancer risk in other groups investigated. This method is possible when the dosimetry of the comparison groups is well known and lung cancer risks are reasonably well-defined. A number of epidemiologic considerations must be taken into account in such comparisons, however. These include age at exposure, length of following, age at expression of or death from cancer, and for underground miners exposed to radon daughters the lung cancer-latent period model applied to long-term exposures. Use of these methods gives results consistent with dosimetry derived from models of bronchial deposition and clearance, as well as reasonable values for the quality factor for alpha radiation. This comparison gives an average equivalent dose for a working population exposed to short-lived isotopes.

30515 (PNL-SA—11049, pp 157-167) **Estimation of lung cancer risk from environmental exposure to airborne plutonium from the Rocky Flats Plant.** Sutherland, J.V. (Univ. of Colorado School of Medicine, Denver). Feb 1983. NTIS, PC A09/MF A01.

From 30. annual meeting of the Radiation Research Society; Salt Lake City, UT, USA (18 Apr 1982).

A three-phase study was undertaken to (1) determine the nature of disagreement among scientists concerning risk of environmental release of plutonium, (2) develop an analytic procedure for determining risk based on clearly stated principles defensible by reference to the literature, and (3) develop estimates of radiation dose to the lung from exposure to plutonium in ambient air for the purpose of evaluating risk to an individual with a specified age and smoking history. Eleven epidemiologists, biostatisticians and radiation scientists participated in Phase I of the study. It was shown that no clearly stated analytical principles for risk estimation were in common use, resulting in widely divergent risk estimates. Five of these disagreeing scientists in Phase I (including all cancer epidemiologists in the Denver metropolitan area) were chosen for Phase II of the study. A single analytic procedure was developed which was unanimously agreed upon. This procedure was dependent on the estimate of dose to the lung from ambient air levels of Rocky Flats plutonium. In Phase III of the study, a panel of four radiation scientists developed a procedure for estimation of dose to the lung from chronic exposure to plutonium ambient air levels. Results from all phases of the study were used to develop a method for estimation of relative risk of lung cancer for an individual, given plutonium dose to the lung, age, smoking history and other radiation exposure.

30516 (PNL-SA—11049, pp 168-177) **Estimation of the bronchial cancer risk from the inhalation of long-lived alpha emitting radionuclides.** Johnson, J.R. (Atomic Energy of Canada, Ltd., Ontario); James, A.C.; Birchall, A. Feb 1983. NTIS, PC A09/MF A01.

From 30. annual meeting of the Radiation Research Society; Salt Lake City, UT, USA (18 Apr 1982).

It is generally accepted that the inhalation of alpha emitting ^{222}Rn progeny is associated with an increased risk of bronchial cancer resulting from the dose to basal cells of the bronchial epithelium. Therefore, it is of interest to calculate doses to these cells from the inhalation of other alpha emitting materials, and to estimate the risk of bronchial cancer by dosimetric comparison with ^{222}Rn progeny. This paper reports the results of basal cell dose calculations from the inhalation of insoluble compounds of ^{234}U, ^{235}U, ^{238}U, and ^{239}Pu. These doses, along with recent dose and risk estimates for ^{222}Rn progeny, are then used to calculate the risk per unit of inhaled activity. These risk estimates are compared to values obtained using the standard International Commission on Radiological Protection (ICRP) lung model and ICRP estimates of risk per unit dose. The risk from ^{222}Rn progeny and from long-lived alpha emitting radionuclides in uranium mines are also compared.

30517 (PNL-SA—11049, pp 178-188) **Theory of age dependence in the incidence of lung carcinomas following inhalation of a radioactive atmosphere.** Crawford-Brown, D.J. (Oak Ridge National Lab., TN). Feb 1983. NTIS, PC A09/MF A01. Contract W-7405-ENG-26.

From 30. annual meeting of the Radiation Research Society; Salt Lake City, UT, USA (18 Apr 1982).

A theory is developed to provide a tool for assessing the effect of age on the induction of lung carcinomas following exposure to a radiocontaminated atmosphere. Estimates are made of the pattern of deposition and disintegration of inhaled radionuclides in the lungs of all human age groups. These figures are converted to estimates of basal nuclei doses as well as the dose to the average lung mass. This information is then combined with a theory relating dose, the number of irradiated cells, and the rate of turnover of those cells to the risk of developing lung cancer. Lastly, it is shown that this information may be coupled to the atomic bomb survivor data to provide risk estimates for instances of non-uniform irradiation. An example employing the theoretical model indicates that the relative risk to children can be larger than that to adults by more than an order of magnitude. The impact of various conceptual models of risk is underlined, particularly as it applies to the interpretation of the follow-up period for the atomic bomb survivor data.

30518 **Effect of hypertonicity and X radiation on DNA synthesis in normal and ataxia-telangiectasia cells.** Painter, R.B.; Young, B.R. (Univ. of California, San Francisco). *Radiation Research;* **92**: No. 3, 552-559(Dec 1982).

Normal human cells and cells from patients with ataxia-telangiectasia (A-T) were exposed to culture medium made hypertonic by raising the NaCl concentration. The rate of DNA synthesis in both types of cells was depressed as a function of increasing hypertonicity. When cells of both types were exposed to X radiation and incubated in hypertonic medium, DNA synthesis appeared to be more radioresistant than in cells incubated in normal medium. Velocity sedimentation analysis showed that this was due to a hypertonicity-induced inhibition of replicon initiation, which is the same process affected by X radiation, indicating that the two treatments were not additive. After a 5-hr incubation in hypertonic medium, there was a new steady state of replicon initiation and elongation similar to that existing in cells grown in normal medium, except that fewer replicons were participating. At this time DNA synthesis in each type of cell had a characteristic response to radiation, i.e., radiosenstivie in normal cells and radioresistant in A-T cells. These results suggest that radioresistant DNA synthesis in A-T cells is not due to increased condensation of chromatin.

30519 **The repair of potentially lethal and sublethal damage in unfed plateau-phase cultures irradiated at 0.78 Gy/hr.** Freeman, M.L.; Sierra, E.; Dietch, A.D.; Cubbon, R.M. (Columbia Univ., New York). *Radiation Research;* **92**: No. 3, 596-603(Dec 1982). Contract AC02-78EV04733.

Unfed plateau-phase cultures of Chinese hamster ovary (CHO) cells were irradiated at 0.78 Gy/hr to determine if accumulation and repair of sublethal and/or potentially lethal damage diminished as a function of small multiple doses and whether culture age affected repair. The repair of both potentially lethal and sublethal lesions was unaffected by aging or absorbed dose. Furthermore, repair of potentially lethal damage was associated with a decrease in the linear parameter of the equation - $\ln s = \alpha D + \beta D^2$, suggesting that lesions produced by this process can be repaired.

30520 **The turnover of tritium in cell nuclei, chromatin, DNA, and histone.** Commerford, S.L.; Carsten, A.L.; Cronkite E.P. (Brookhaven National Lab., Upton, NY). *Radiation Research;* **92**: No. 3, 521-529(Dec 1982). Contract AC02-76CH00016.

Mice were exposed to constant internal levels of tritiated water starting at conception and continuing until they were 8 months old. At this point, exposure was discontinued and at various intervals thereafter nuclei, chromatin, and chromatin components were isolated from several tissues and analyzed for nonexchangeable tritium. Initially, about two-thirds of the nonexchangeable tritium in cell nuclei is present in components other than chromatin, but after 8 weeks these labeled components have either vanished or dwindled into relative insignificance and essentially all tritium remaining in the nucleus is in DNA or histone. Although the amount of tritium initially present in DNA and histone is small compared to the that in nuclear water, it remains much longer. Consequently the radiation dose from tritium in DNA plus histone may exceed that from tritiated water in cells with a long life span. However, tritium is incorporated into DNA and histones of cells only when they reproduce. Therefore, after transient exposure to tritiated water, this component will contribute significantly to the radiation of only those nuclei from cell with a long life span which happen to reproduce at the time of exposure. Such cells are rare in adults but common in juveniles and embryos.

30521 **Fission-spectrum neutrons at reduced dose rates enhance neoplastic transformation.** Hill, C.K.; Buonaguro, F.M.; Myers, C.P.; Han, A.; Elkind, M.M. (Argonne National Lab., IL). *Nature (London);* **298**: 67-69(1 Jul 1982). Contract W-31-109-ENG-38.

The effect of reduced dose rates of radiation on neoplastic transformation was studied using the C3H/1OT1/2 mouse embryo-derived cell line developed by Reznikoff et al. In this cell system,

transformation can be measured by scoring the foci of piled-up cells that occur after the loss of contact inhibition of growth. We report here that reduction of the dose rates of fission-spectrum neutrons (of mean energy 0.85 MeV) from 38.5 or 10.3 to 0.43 and 0.086 rad min^{-1} has no effect on cell killing but increases transformation frequency. These data are in contrast to previously published results obtained with ^{60}Co γ rays where reduction of the dose rate resulted in a marked reduction in transformation frequency. Although cancer induction in man involves many factors besides those at the cellular level, the implication from our findings is that the risk of cancer induction due to work-related exposure to neutrons in the nuclear power industry may be greater than previously thought.

30522 Characterization of a UV-resistant mutant of CHO-Kl with normal repair activity. Newman, C.N. (Pacific Northwest Lab., Richland, WA). *Mutation Research;* **96**: 99-108(1982). Contract AC06-76RL01830.

The biological and repair responses of Mut 8-16, an ultraviolet radiation (UV)-resistant derivative of CHO-Kl, were characterized with respect to UV and to the active chemical carcinogen, benzo(a)pyrene-4,5-oxide. In comparison to the parent, the UV-survival response curve of this mutant showed a significantly larger shoulder but little or no difference in the slope of the exponential survival region. In addition, the mutant cell line demonstrated significantly larger mutation frequencies at high survival UV fluences, but smaller mutation frequencies at high survival equitoxic concentrations of the carcinogen benzo(a)pyrene-4,5-epoxide relative to the parent cell. However, these relative differences in mutation frequencies between parent and mutant appeared to decrease as survival decreased. Despite these observations there were no measurable differences in excision-repair, or in post-replication repair although the mutant appeared to show a nominal reduction (not an enhancement) of replication-repair activity following the UV exposure. These data imply there is another lesion recognition system in CHO cells whose effects on survival and mutation are best observed at low doses of carcinogen and/or radiation but which are masked at higher doses where major repair processes dominate. The dissimilar relationship of cytotoxicity to mutation induction frequency observed in UV and carcinogen treated mutant vs. parent cell lines, imply that the probabilities for lethality and mutation are independent of one another in the presence of otherwise unrepaired (residual) damage.

30523 Deposition and retention of 0.1 μm $^{67}Ga_2O_3$ aggregate aerosols in rats following whole body exposures. Wolff, R.K.; Griffis, L.C.; Hobbs, C.H.; McClellan, R.O. (Lovelace Biomedical and Environmental Research Inst., Albuquerque, NM). *Fundamental and Applied Toxicology;* **2**: 195-200(1982). Contract AC04-76EV01013.

Determinations were made of respiratory tract deposition and gastrointestinal tract burdens following whole body inhalation exposures, typical of those used in many chronic exposures; these were compared to values obtained in nose-only exposures. Fischer-344 rats were exposed in large volume chambers, in a whole body mode, to 0.1 μm volume median diameter (VMD) $^{67}Ga_2O_3$ particles 5 hrs/day. Deposition per unit of exposure time and retention were essentially identical following either 1 or 3 day exposures. The lung deposition of particles was 2.8 units/hr for males and 2.2 units/hr for females if the exposure concentration was expressed as 1 unit/L. These values represent a deposition of approximately 15% of the inhaled particles, similar to values obtained for nose-only exposures. Aerosol deposition per kgm body weight was 24% higher in females than males. Passage of material into the gastrointestinal tract was 1.6-fold greater for these whole body exposures as compared to nose-only exposures to the same aerosol mainly resulting from extra material ingested by grooming of the pelt. Approximately 60% of the pelt burden was calculated to be ingested following whole body exposures.

30524 Psoralen-plus-light damage and repair in transforming DNA of Bacillus subtilis. Hadden, C.T. (Oak Ridge National Lab., TN). pp 143-151 of Genetic exchange: a celebration and a new generation. Streips, U.N.; Guild, W.R.; Goodgal, S.H.; Wilson, G.A. (eds.). New York, NY; Marcel Dekker, Incorporated (1982). Contract AS05-76EV04568;W-7405-ENG-26.

The relative contributions of excision and recombination in the repair of damage by a 8-methoxypsoralen (8-MOP) plus black light to Bacillus subtilis have been investigated. The results indicate that the pyrimidine dimer excision system and a recombination pathway are probably both involved in repair of lethal damage to cells exposed in vivo to 8-MOP plus black light, but repair is not very efficient. Transforming DNA exposed in vitro to 8-MOP plus black light was inactivated mainly by crosslinks rather than by monoadducts, and was repaired predominantly by an incision-dependent process. There was very little demonstrable damage-induced recombination in transforming DNA.

30525 Studies on the multistage nature of radiation carcinogenesis. Fry, R.J.M. (Oak Ridge National Lab., TN); Ley, R.D.; Grube, D.; Staffeldt, E. *Carcinogenesis (New York);* **7**: 155-165(1982). Contract W-7405-ENG-26;W-31-109-ENG-38.

The effectiveness of ionizing radiation and ultraviolet radiation (uvr) in the induction of carcinogenesis in mice and humans is discussed. It is clear that with low-dose levels of ionizing or uvr, the number of initiation events exceeds the numbers of tumors that grow to a detectable size. Ionizing radiation, which is a complete carcinogen, appears to be a more effective initiator than an enhancer or promoter. In the case of uvr, with or without photosensitizers such as psoralens, the requirement of a relatively large number of exposures for carcinogenesis suggests that the expression of the initiated cells as frank tumors requires a number of events spread out over the time of the development of the tumor. (KRM)

30526 Risk estimation and decision making: the health effects on populations of exposure to low levels of ionizing radiation. Fabrikant, J.I. *Pediatric Dentistry;* **3**: No. 2, 400-413(1982). Contract W-7405-ENG-48.

Presented is a background for an understanding of the potential health effects in populations exposed to low-level radiation. Discussed is the knowledge about the health effects of low-level radiation. Comments on how the risks of radiation-induced cancer and genetically-related ill-health in man may be estimated, the sources of the scientific and epidemiological data, the dose-response models used, and the uncertainties which limit precise estimates of excess risks from radiation. Also discussed are the implications of numerical risk estimation for radiation protection and decision-making for public health policy.

30527 Biophysical aspects of radiation carcinogenesis. Kellerer, A.M.; Rossi, H.H. pp 569-616 of Comprehensive treatise. Volume 1, 2nd edition. Becker, F.F. (ed.). New York, NY; Plenum Publishing Corporation (1982). Contract AC02-78EV04733.

The application of radiation physics to the subject of radiation carcinogenesis is described and quantitated in this review. Interaction of radiation and matter, and general stochastic considerations of linear dose-effect relationships are reviewed. The chapter also discusses the quadratic dependence of the cellular effect on specific energy. Some practical applications of biophysics to radiation carcenogenesis including cellulor transformation studies, induction of neoplasms in the Spraque-Dauley rat, and radiation leukomogenesis studies, are described. A formal derivation of a biophysical theorem is given in an appendix. (KRM)

30528 Hypersensitivity to mutation and sister-chromatid-exchange induction in CHO cell mutants defective in incising DNA containing UV lesions. Thompson, L.H.; Brookman, K.W.; Dillehay, L.E.; Mooney, C.L.; Carrano, A.V. (Univ. of California, Livermore). *Somatic Cell Genetics;* **8**: No. 6, 759-773(1982). Contract W-7405-ENG-48.

Five UV-sensitive mutant strains of CHO cells representing different genetic complementation groups were analyzed for their ability to perform the incision step of nucleotide excision repair after UV exposure. The assay utilized inhibitors of DNA synthesis to accumulate the short-lived strand breaks resulting from repair incisions. After 6 J/m^2, each of the mutants showed $< 10\%$ of the incision rate of the parental AA8 cells. After 50 J/m^2, the rate in AA8 was similar to that at 6 J/m^2, but the rates in the mutants were significantly higher ($\sim$ 20% of the rate of AA8). Thus by this

incision assay the mutants were phenotypically indistinguishable. Each of the mutants were hypersensitive to mutation induction at both the hprt and aprt loci by a factor of 10, and in the one strain tested ouabain resistance was induced sevenfold more efficiently than in AA8 cells. Sister chromatid exchange was also induced with sevenfold increased efficiency in the two mutant strains examined. Thus, here CHO mutants resemble xeroderma pigmentosum cells in terms of their incision defects and their hypersensitivity to DNA damage by UV.

30529 **p-Aminobenzoic acid-sunlamp sensitization of pyrimidine dimer formation and transformation in human cells.** Sutherland, B.M. (Brookhaven National Lab., Upton, NY). *Photochemistry and Photobiology;* **36**: 95-97(1982).

In the presence of sunlamp radiation, p-aminobenzoic acid sensitizes pyrimidine dimer formation in the DNA of human skin fibroblasts. It also sensitizes the sunlamp-induced transformation of such cells to anchorage-independent growth.

5602 Thermal Effects

REFER ALSO TO CITATION(S) 30396

5603 Chemicals Metabolism And Toxicity

REFER ALSO TO CITATION(S) 28875, 28981, 28981, 28981, 28982, 28982, 29076, 29078, 29079, 29080, 29081, 29082, 29083, 29084, 29084, 29085, 29086, 29087, 29088, 29089, 29090, 29091, 29092, 29750, 30341, 30359, 30360, 30413, 30443, 30522

30530 **(CONF-820356—4) Relation of mouse specific-locus tests to other mutagenicity tests and to risk estimation.** Russell, W.L. (Oak Ridge National Lab., TN (USA)). 1982. Contract W-7405-ENG-26. 28p. NTIS, PC A03/MF A01. Order Number DE83009836.

From Conference of the National Institute of Environmental Health Sciences; Research Triangle Park, NC, USA (28 Mar 1982).

A major difficulty in reaching estimates of risk from the wide array of chemicals to which man is exposed is that results from the simple, relatively inexpensive, mutagenicity tests, e.g., those obtained with Salmonella, have given poor correlation with the results from tests, such as the specific-locus test, that measure mutation frequency in the offspring of treated mammals. This paper discusses the use and value of the specific-locus test in mice, presents evidence that the results of specific-locus tests are representative of the mutagenicity of various chemicals to humans, and proposes hypotheses why the test does not correlate with those on simple systems (e.g., the Ames test). (ACR)

30531 **(CONF-830341—1) Response of the North American corn belt to climatic warming.** Blasing, T.J.; Solomon, A.M. (Oak Ridge National Lab., TN (USA)). 1983. Contract W-7405-ENG-26. 17p. NTIS, PC A02/MF A01. Order Number DE83009830.

From Conference on interactions between climate and biosphere; Osnabruck, F.R. Germany (21 Mar 1983).

The climate of the North American corn belt was characterized as part of an effort to estimate the effects of climatic change on that agricultural region. Heat and moisture characteristics of the current corn belt were first identified. Locations of those characteristics were then mapped, based on a climate simulated to result from doubling the amount of atmospheric CO_2. Such projections of corn-belt location were made both with and without allowance for earlier planting dates under a warmer climate. Because the direct effects of CO_2 on plants, improvements in farm technology, and plant breeding are not considered, the resulting projections represent an extreme or worst case. Results indicate that even for such a worst case, climatic conditions favoring corn production would not extend very far into Canada. Greatest translocations are projected for the western, or driest, part of the corn belt where other crops such as winter wheat could replace corn. However, this kind of exercise clearly shows that the use of climate-model output requires several highly questionable assumptions about changes in the timing and regional distribution of precipitation accompanying a climatic warming. Increased use of climatic data and improved specification of CO_2-induced increases in water-use efficiency of corn are suggested for more credible projections of corn-belt responses to increasing CO_2.

30532 **(DOE/EV/10598—1) Non-regulatory and cost-effectiveness control of carcinogenic hazard. The beginnings: a methodology for using animal data to decrease uncertainty in human risk of carcinogens released by energy technologies.** Crouch, E.A.C.; Feller, J.; Fiering, M.B.; Hakanoglu, E.; Wilson, R.; Zeise, L. (Harvard Univ., Cambridge, MA (USA). Energy and Environmental Policy Center). Sep 1982. Contract AC02-81EV10598. 12p. NTIS, PC A02/MF A01. Order Number DE83009531.

A logical cost effective procedure for assessing carcinogenic risk associated with emerging energy technologies is outlined. All chemicals are assumed to be carcinogenic with a potency that has to be measured. In this scheme a non-carcinogen is a chemical with zero potency. If the carcinogenic potency in animals has not been measured, it may be assumed from an a priori measure. Using estimates of potency, exposure, and an interspecies factor (which also accounts for uncertainties in extrapolating the animal data to man), an estimate of risk and the uncertainty associated with that estimate is made, together with upper bounds on the risk. If the upper bound is small the risk is negligible and can be ignored. If it is large, the exposure at the level proposed should not be permitted. However further information may be obtained which changes the risk estimate or lowers the uncertainty so that the upper bound on the risk is reduced. Notice that estimation of the uncertainty is as important as estimation of a best value of risk.

30533 **(LA—9479-PR, pp 11-12) Effects of solubility on tumorigenesis of two shale crude oils and two natural petroleums.** Wilson, J.S.; Holland, L.M. Oct 1982. NTIS, PC A08/MF A01.

In Los Alamos Life Sciences Division's biomedical and environmental research programs. Progress report, January-December 1981.

The possible contribution of solubility to overall toxicity and tumorigenesis of two shale oils and two natural petroleums was studied using three vehicles: acetone, cyclohexane, and a mixture of 30% cyclohexane-70% acetone. It seems apparent that the solubility of these test oils in these vehicles has an effect on cytotoxicity and tumor latency but minimal effect on overall tumor incidence in mice. (DLS)

30534 **(LA—9479-PR, pp 13-16) Dose-response study for three shale crude oils and two natural petroleums.** Holland, L.M.; Wilson, J.S. Oct 1982. NTIS, PC A08/MF A01.

In Los Alamos Life Sciences Division's biomedical and environmental research programs. Progress report, January-December 1981.

The mouse epidermal carcinogenesis assay has been used to evaluate dose-response carcinogenic potency for three shale oils and two natural petroleums. Parameters studied included tumor incidence and latency resulting from various concentrations of each test material. The shale oils appear to be more potent than the natural petroleums in tumorigenic potency and demonstrated a process-dependent difference. (DLS)

30535 **(LA—9479-PR, pp 17-19) Inhalation studies.** Holland, L.M.; Wilson, J.S.; Tillery, M.I.; Gonzales, M.; Vigil, E.A.; Royer, G.; Stavert, D.; Archuleta, D. Oct 1982. NTIS, PC A08/MF A01.

In Los Alamos Life Sciences Division's biomedical and environmental research programs. Progress report, January-December 1981.

Long-term, high concentration inhalation studies of shale dusts using female Fisher 344 rats were conducted using raw shale, spent shale, and quartz. Histopathological examinations revealed multiple indications of fibrosis and primary lung tumors in each group. Based on current data, it is indicated that high exposure levels have led to a lung-scar cancer phenomenon. (DLS)

30536 (LA—9479-PR, pp 19-21) **Effect of shale oil and ultraviolet light on delayed hypersensitivity in mice.** Baron, P.A. Oct 1982. NTIS, PC A08/MF A01.

In Los Alamos Life Sciences Division's biomedical and environmental research programs. Progress report, January-December 1981.

Delayed type hypersensitivity (DTH) to 2, 4-dinitro-1-fluorobenzene (DNFB) in mice is studied with respect to the interactions of ultraviolet light and shale oil. Results indicate that the combination of either UVA or UVB with PCSO shale oil does not result in an additional deleterious effect above that associated with the shale oil alone. (DLS)

30537 (LA—9479-PR, pp 26-30) **Nickel arsenide (Ni_5As_2): the relationship between its solubility and its toxicity and mutagenicity.** Gurley, L.R.; Tobey, R.A.; Valdez, J.G.; Miglio, J.J.; Cox, S.H.; Barham, S.S. Oct 1982. NTIS, PC A08/MF A01.

In Los Alamos Life Sciences Division's biomedical and environmental research programs. Progress report, January-December 1981.

To determine whether fugitive nickel arsenides from an oil shale retort process could pose a threat to personnel or organisms in the environment, the toxicity of Ni_5As_2 particles suspended with Chinese hamster cells in culture were examined. It was concluded the soluble produce of Ni_5As_2 is acutely toxic to cells at low concentrations (less than 1 ppM) but not mutagenic. (DLS)

30538 (LA—9479-PR, pp 36-38) **Zinc-induced enhancement of resistance to alkylating agents.** Tobey, R.A.; Enger, M.D.; Griffith, J.K.; Hildebrand, C.E. Oct 1982. NTIS, PC A08/MF A01.

In Los Alamos Life Sciences Division's biomedical and environmental research programs. Progress report, January-December 1981.

Results presented indicate the existence in cadmium-resistant cultured cell variants of Chinese hamster cells of a non-metallothionein dependent, zinc-inducible protective response which grossly decreases alkylating-agent toxicity. Possible mechanisms for this zinc-induced response are discussed. (DLS)

30539 (LA—9479-PR, pp 47-49) **Genes coding for metal-induced synthesis of RNA sequences are differentially amplified in mammalian cells.** Walters, R.A.; Enger, M.D.; Hildebrand, C.E.; Griffith, B.; Griffith, J.K. Oct 1982. NTIS, PC A08/MF A01.

In Los Alamos Life Sciences Division's biomedical and environmental research programs. Progress report, January-December 1981.

In order to define the role(s) played by cellular processes in cadmium detoxification, the molecular events associated with cadmium exposure have been examined in Cd^{++}-resistant and Cd^{++}-sensitive Chinese hamster cells. Three cadmium-resistant variants have been selected by stepwise culture in increasing Cd^{++} concentrations. Studies designed to probe cellular responses to Cd^{++} treatment indicate Cd^{++} treatment of the resistant variants induces the synthesis of a highly abundant poly A^+ RNA class, a major portion of which is metallothionein mRNA. Not only is this RNA class differentially regulated in resistant variant cells but the structural genes encoding these inducible RNAs are differentially amplified in the resistant variants. However, there is not a direct correlation between the degree of gene amplification and resistance.

30540 (LA—9479-PR, pp 49-52) **Molecular cloning and DNA sequence of the Chinese hamster metallothionein-II gene.** Griffith, B.B.; Walters, R.A.; Griffith, J.K. Oct 1982. NTIS, PC A08/MF A01.

In Los Alamos Life Sciences Division's biomedical and environmental research programs. Progress report, January-December 1981.

Studies have focused on the genetic mechanisms which regulate the concentrations of essential and toxic trace metals in normal and abnormal mammalian cells. In this regard, researchers recently reported that cadmium-sensitive and cadmium-resistent Chinese hamster cells differ significantly in their ability to induce a class of low-molecular-weight proteins, which includes the metal-binding proteins, metallothionein I and II. In order to study the genetic basis of such differences, we have constructed recombinant DNA-containing plasmids from the mRNA that encodes these differentially induced proteins. Researchers describe here the details of the construction of these recombinant DNA species and based on DNA nucleotide sequence data, identify one component of this induced battery as metallothionein II.

30541 (LA—9479-PR, pp 52-54) **Differential induction by cadmium of a low-complexity ribonucleic acid class in cadmium-resistant and cadmium-sensitive mammalian cells.** Griffith, J.K.; Enger, M.D.; Hildebrand, C.E.; Walters, R.A. Oct 1982. NTIS, PC A08/MF A01.

In Los Alamos Life Sciences Division's biomedical and environmental research programs. Progress report, January-December 1981.

The Chinese hamster ovary (CHO) cell subline Cd/sup r/20F4 is distinguished from the parental CHO line by a 100 fold higher cadmium toxic threshold, a 50 fold or greater cadmium-inducible metallothionein synthesis rate, and a 50 fold or greater level of cadmium-inducible translatable metallothionein messenger ribonucleic acid (mRNA). We determined the size distribution of the Cd/sup r/20F4 RNA species which were both highly abundant and inducible by cadmium. Highly abundant, cadmium-induced RNA species were identified by the increase in the ratio of ^3H:^{14}C radioactivity. A single peak of high ^3H:^{14}C radioactivity was resolved from the RNA mixture and migrated with RNA whose modal chain length was 400 nucleotides. This RNA encodes four inducible proteins, including metallothionein. The abundant, inducible RNA sequences comprise about half of the newly synthesized RNA mass in the 400-NT RNA fraction. We conclude that about 4% of the total newly synthesized RNA from cadmium-induced Cd/sup r/20F4 cells represents cadmium-induced abundant RNA sequences.

30542 (LA—9479-PR, pp 54-56) **Somatic cell genetics approaches to the analysis of regulation of metallothionein gene expression.** Hildebrand, C.E.; Chen, D.J.C.; Enger, M.D.; Griffith, J.K.; Tobey, R.A.; Walters, R.A. Oct 1982. NTIS, PC A08/MF A01.

In Los Alamos Life Sciences Division's biomedical and environmental research programs. Progress report, January-December 1981.

Studies of the responsiveness of the CHO cell to either Cd^{2+} or Zn^{2+} indicated that this cell line was deficient in expression of MT genes at the phenotypic level. Several stable Cd^{2+}-resistant variants have been derived from the Cd^{2+}-sensitive CHO cell. These variants designated Cd/sup r/2C10, 20F4, and 30F9 show Cd^{2+}-toxic thresholds of 2, 26, and 40 μM $CdCl_2$, while the CHO cell has a toxic threshold of 0.2 μM Cd^{2+}. In all of the Cd^{2+}-resistant variants, induction of MT gene expression is a major factor in conferring the Cd^{2+}-resistant phenotype. In addition to induction of MT genes, several other metal-inducible factors have been identified with the Cd^{2+}-resistant phenotype. To further analyze the genetic regulation of the Cd^{2+}-resistant phenotype, intraspecific somatic cell hybrids have been constructed between CHO and the Cd/sup r/2C10 variant. The properties of three of the CHO x Cd/sup r/2C10 hybrids are summarized.

30543 (LA—9479-PR, pp 56-59) **Inducibility of metallothionein gene expression as an indicator of DNA damage and repair proficiency in human cells.** Hildebrand, C.E.; Strniste, G.F.; Hanners, J.L. Oct 1982. NTIS, PC A08/MF A01.

In Los Alamos Life Sciences Division's biomedical and environmental research programs. Progress report, January-December 1981.

In the present report, evidence is presented to suggest the general utility of a ubiquitous inducible gene function in studies of DNA damage and repair both in cultured cells and in vivo. The specific genes of interest in this study code for low-molecular-weight, metal-binding proteins, metallothioneins. In this study we have characterized the Zn^{2+}-mediated induction of metallothionein in normal human skin fibroblasts and in xeroderma pigmentosum (XP) cells having a defect in the ability to repair lesions introduced into DNA by ultraviolet (uv) light. Evidence is provided indicating that this inducible system may have value in detecting repair defi-

ciency conditions for a specific class of DNA lesions (transcription-termination events) in human populations.

30544 (LA—9479-PR, pp 59-61) **Quantitation of mutations induced by metabolically activated mutagens in normal human fibroblasts.** Chen, D.J.; Okinaka, R.T.; Strniste, G.F. Oct 1982. NTIS, PC A08/MF A01.

In Los Alamos Life Sciences Division's biomedical and environmental research programs. Progress report, January-December 1981.

Many chemical mutagens such as polycyclic aromatic hydrocarbons (PAH), aromatic amines, nitrosamines, and aflatoxins require metabolism by mixed-function oxidases and related enzymes to induce such biological endpoints as cell cytotoxicity and mutagenicity. We have adapted a rat-liver microsomal S9 activation system both for cultured Chinese hamster ovary (CHO) cells and normal human skin fibroblasts. We have been able to show that metabolic activation of three known promutagens/procarcinogens results in mutations at the HGPRT locus in normal embryonic human skin fibroblast cells (GM10).

30545 (LA—9479-PR, pp 61-65) **Mutagenicity of various oil shale retort process waters in the Ames/Salmonella bioassay.** Nichols, J.W.; Strniste, G.F. Oct 1982. NTIS, PC A08/MF A01.

In Los Alamos Life Sciences Division's biomedical and environmental research programs. Progress report, January-December 1981.

Using Salmonella tester strains TA98 and TA100 researchers have examined for mutagenic activity a variety of process waters from the Paraho facility (aboveground retort), the modified in situ retort facilities of Occidental and Rio Blanco, the true in situ retort of Geokinetics and waters obtained from the Fischer retorting of an Estonian oil shale sample. The results are presented. Mutagenic activity was seen only in those reactions which contained S9 fraction. That is, researchers were unable to detect any direct acting mutagenic activity in these waters when assessed with this in vitro test. Although each water sample was examined over a dose range of up to 300 μl, the dose-response curves for mutagenically active waters were generally linear only up to sample volumes of < 100 μl. Deviations from a linear dose response can be partially accounted for by cytotoxic properties of these active waters at higher concentrations.

30546 (LA—9479-PR, pp 65-68) **Genotoxicity of natural and synthetic oils in the Ames/Salmonella test.** Nichols, J.W.; Strniste, G.F. Oct 1982. NTIS, PC A08/MF A01.

In Los Alamos Life Sciences Division's biomedical and environmental research programs. Progress report, January-December 1981.

Dimethyl sulfoxide (DMSO) extracts of a variety of natural and synthetic oils and upgraded petroleum products were tested for both cytotoxic and mutagenic activities in the Ames/Salmonella bioassy. Using both TA 98 and TA 100 bacterial strains with and without the addition of Aroclor 1254-induced rat hepatic S9 fraction in our routine screening strategy. In agreement with previous observations, natural petroleums are only marginal in activity or nonmutagenic. Criteria for mutagenicity is a response for the induction of maximum number of histidine (his^+) revertants over the dose range tested equaling 1.7 X or greater the historical background mutation frequency, indicating significant activity in the sample ($p < 0.01$). The various crude oils from different in situ processes (Occidental, Geokinetics, and Rio Blanco) all show weak but significant mutagenic activity. The 150 ton simulated MIS (LETC) oil, the coal derived medium distillate blend (SRCII) and the aboveground retort composite crude oil (PRHO 601) are strongly mutagenic, yet this activity in the latter oil can be completely eliminated by hydrotreatment.

30547 (LA—9479-PR, pp 68-71) **Light activation of oil shale retort process waters.** Strniste, G.F.; Chen, D.J.; Okinaka, R.T. Oct 1982. NTIS, PC A08/MF A01.

In Los Alamos Life Sciences Division's biomedical and environmental research programs. Progress report, January-December 1981.

Five drug-resistent markers have been employed to monitor mutagenesis induced in CHO cells by oil shale process water plus near ultraviolet light (nuv). Results indicate the sample of above ground retort process water was strongly mutagenic at all loci, whereas true in-situ retort process water was a weaker mutagen. Also both cytotoxicity and mutagenicity induced in CHO cells were examined after their exposure to aboveground retort process water and natural sunlight. (ACR)

30548 (LA—9479-PR, pp 71-73) **Light activation of natural and synthetic petroleums.** Strniste, G.F.; Bingham, J.M.; Chen, D.J.; Okinaka, R.T. Oct 1982. NTIS, PC A08/MF A01.

In Los Alamos Life Sciences Division's biomedical and environmental research programs. Progress report, January-December 1981.

This report summarizes data concerning nuv-induced cytotoxicity and mutagenicity in cultured Chinese hamster ovary (CHO) cells after treatment with dilutions of various natural or synthetic petroleums. The data indicate that significant mutagenicity occurs in cells exposed to high dilutions of certain synthetic crude oils and nominal exposure to nuv.

30549 (LA—9479-PR, pp 73-75) **Benzo(a)pyrene metabolism and mutation induction in CHO cells using either rat liver homogenate or Syrian hamster embryonic cell-mediated activation.** Okinaka, R.T.; Strniste, G.F.; Chen, D.J.C. Oct 1982. NTIS, PC A08/MF A01.

In Los Alamos Life Sciences Division's biomedical and environmental research programs. Progress report, January-December 1981.

A comparative study of B(A)P metabolism by rat liver homogenates (S9) and Syrian hamster embryonic (SHE) cells suggest that the S9 preparations possess a greater potential in removing cytotoxic and mutagenic species by conjugation mechanisms. A CHO mutation assay incorporating both activation systems to measure cytotoxic and mutagenic effects shows that SHE cells are moie efficient at inducing mutations in CHO than is the S9 preparation. The S9 preparations appear to convert B(a)P into a wider variety of moieties than does the intact hamster cell and possess more extensive conjugation mechanisms which preferentially remove the more mutagenic oxide molecules. (DLS)

30550 (LA—9479-PR, pp 88-90) **Sister chromatid exchange (SCE) analysis in bone marrow of mice treated with shale oils and shale process waters.** Meyne, J. Oct 1982. NTIS, PC A08/MF A01.

In Los Alamos Life Sciences Division's biomedical and environmental research programs. Progress report, January-December 1981.

Female Swiss mice were treated with three intraperitoneal injections of either shale oil diluted in olive oil or process water diluted in saline given at 24-h intervals. Mice were killed 4 h after the last injection. Detection of SCE was based on bromodeoxyuridine tablet methodology and a modified fluorescence plus Giemsa staining procedure. The PCSO sample induced dose-related increases in the frequency of SCE, but even at the 2-ml/kg dose this increase was only about 50% above the control level. At this dose, the frequency of structural aberrations was five times the control value. The PCSO-HT and OCSO samples demonstrated SCE frequencies within the control range at all doses tested. The results after treatment with the three process waters showed no increase in frequency of SCEs was observed, although the doses tested induced about a two-fold increase of structural aberrations. Therefore, it appears that structural aberration analysis is more sensitive than SCE analysis for evaluation of the types of DNA damage induced in murine bone marrow by shale oils and process waters.

30551 (LA—9479-PR, pp 90-92) **Sister chromatid exchange rates in geokinetics oil shale workers.** Campbell, E.W.; Ray, F.A.; Deaven, L.L. Oct 1982. NTIS, PC A08/MF A01.

In Los Alamos Life Sciences Division's biomedical and environmental research programs. Progress report, January-December 1981.

The sister chromatid exchange (SCE) assay applied to human peripheral lymphocytes is used to assess genetic damage to workers of the Geokinetics Inc. in situ oil shale retorting process

site in Utah. SCE rates on 29 individuals studied fell within normal ranges and future samplings from these workers and their families will provide information concerning an SCE rates change as a result of working and living in the environment. (DLS)

30552 (LA—9479-PR, pp 92-93) **Comparison of direct-acting cytogenetic and mutagenic effects of a shale oil retort process water.** Meyne, J.; Chen, D.J. Oct 1982. NTIS, PC A08/MF A01.

In Los Alamos Life Sciences Division's biomedical and environmental research programs. Progress report, January-December 1981.

Process water from an aboveground retort contains direct-acting mutagens which produce substantial mutagenic activity in 6-thioguanine-resistant (6-TG/sup R/) mutants of human embryonic skin fibroblasts. Less severe effects are observed in Chinese hamster ovary (CHO) cell mutants. Since many mutagenic agents are also clastogenic, researchers have compared the cytogenetic and mutagenic effects of this process water under the same experimental conditions. The CHO cells demonstrated significant, dose-related increases in the frequency of chromosomal breaks observed. The frequency of tetraploid cells was increased in both cell types but dose-related only in human fibroblasts. Although there is no quantitative correlation between mutation frequency and the frequency of either chromosomal breaks or tetraploid cells in cultures treated with process water, this study provides additional support to the hypothesis that many mutagens also induce chromosomal changes.

30553 (LA—9479-PR, pp 94-97) **Effects of prolonged inhalation exposure to oil shale dust.** Halleck, M.S.; Saunders, G.C.; Tate, E.H.; Stevenson, A.P.; Wilson, J.S.; Stewart, C.C.; Spall, W.D.; Martinez, A. Oct 1982. NTIS, PC A08/MF A01.

In Los Alamos Life Sciences Division's biomedical and environmental research programs. Progress report, January-December 1981.

The development of shale oil as an alternative energy source poses potential health hazards to those associated with the mining and milling of raw shales. Experiments designed to assess the extent of pulmonary damage from inhalation exposure to highly respirable forms of oil shale dusts are in progress. These experiments have provided the materials to develop assay systems to measure cellular and biochemical Parameters on fluids lavaged from control and inhalation-exposed animals as well as biochemical measures of damage to lung tissues. This report describes preliminary results on a small sample of animals obtained after exposure for 16 months to a heavy aerosol dose of raw Paraho shale.

30554 **Sulfur and nitrogen uptake by loblolly pine seedlings as influenced by nitrogen and sulfur addition.** Kelly, J.M. (Tennessee Valley Authority, Muscle Shoals, AL); Johnson, D.W. *Forest Science;* **28**: No. 4, 725-731(Dec 1982). Contract W-7405-ENG-26.

The influence of increasing levels of nitrogen addition at several levels of sulfur input on nitrogen and sulfur uptake by loblolly pine seedlings was evaluated in a greenhouse study. All possible combinations on nitrogen and sulfur were incorporated into soil collected from the A horizon of a southeastern forest soil at rates of 0, 200, 500, and 1,000 μg/g of N, and 0, 14, 35, and 70 μg/g of S. Soil samples collected at the end of the study indicated that a similar amount of soil SO_4-S had been mineralized in all treatment combinations, compared to a general pattern of increasing soil nitrogen mineralization with increasing nitrogen input. Most mineralized sulfate appeared to come from nonprotein organic compounds as there was not a significant concomitant release of nitrogen. Both shoot and root biomass responded significantly to nitrogen addition, but there was no sulfur or nitrogen-sulfur interaction response. Nitrogen treatment generally increased shoot nitrogen concentration compared to a general decrease in shoot total-, sulfate-, and organically bound-sulfur. Organically bound-sulfur concentrations were 26 to 60 percent below sulfur values calculated from an S/N ratio of 0.03 on a gram atom basis. The results show that increased nitrogen addition affected both growth and sulfur status of loblolly pine seedlings, but not entirely in the manner predicted by theoretical considerations.

30555 **Macromegakaryocytosis after hydroxyurea.** Ebbe, S. (Univ. of California, Berkeley); Phalen, E. *Proceedings of the Society for Experimental Biology and Medicine;* **171**: No. 2, 151-157(Nov 1982). Contract AC03-76SF00098.

A single injection of hydroxyurea (OHU) produced transient megakaryocytopenia in mice. An increase in the average mean size of mature, stage III megakaryocytes coincided with their depopulation. This was due to a selective reduction in numbers of smaller cells. In contrast, the macromegakaryocytosis of immunothrombocytopenia showed substantial increases in numbers of larger cells and reductions in smaller. Further reduction in numbers of smaller cells occurred when OHU was given to mice with immunothrombocytopenia, and the megakaryocytopenia was somewhat more severe than that produced by OHU in normal mice. OHU produced mild thrombocytopenia in normal mice and compromised recovery of the platelet count from immunothrombocytopenia. The most likely explanation for the increase in mean megakaryocyte size in the hypomegakaryocytic state produced by OHU is that the temporary imbalance between a low rate of influx and a normal rate of maturation produced a shift of the age distribution of the cells due to a deficiency of immature cells.

30556 **Effects of dewatering on chinook salmon redds: tolerance of four developmental phases to daily dewaterings.** Becker, C.D.; Neitzel, D.A.; Fickeisen, D.H. (Pacific Northwest Lab., Richland, WA). *Transactions of the American Fisheries Society;* **111**: No. 5, 624-637(Sep 1982). Contract AC06-76RL01830.

Four intergravel developmental phases of chinook salmon Oncorhynchus tshawytscha were dewatered experimentally in artificial redds. The redds consisted of aquaria containing a gravel mix and supplied with 4 liters of water per minute at 10 C. Cleavage eggs and embryos (the egg phases), and eleutheroembryos and pre-emergent alevins (the alevin phases) were dewatered 20 consecutive times in 22-day tests. The egg phases were considerably more tolerant than alevins. Some cleavage eggs were killed by 12- and 16-hour daily dewaterings, but embryos survived up to 22-hour daily dewaterings. Embryos also tolerated extended, multiple dewaterings (over 60% survival for four consecutive 118-hour periods) and one-time, continuous dewatering for up to 12 consecutive days (over 80% survival). In contrast, about half the eleutheroembryos were killed by 4-hour daily dewaterings, and nearly all pre-emergent alevins were killed by 1-hour daily dewaterings. Intergravel temperatures were affected by insolation and air temperature. Intergravel temperatures increased to lethal levels during dewatering of cleavage eggs in early fall, and limited their survival. Growth of egg phases from some females was retarded by dewatering, but this phenomenon was not consistent for all egg groups. The size of surviving eleutheroembryos decreased as the length of daily dewatering periods increased.

30557 **Dimethylnitrosamine demethylase activity in Drosophila melanogaster.** Waters, L.C.; Nix, C.E.; Epler, J.L. (Oak Ridge National Lab., TN). *Biochemical and Biophysical Research Communications;* **106**: No. 3, 779-785(15 Jun 1982). Contract W-7405-ENG-26.

A dimethylnitrosamine (DMN) demethylase with levels of activity comparable to that in uninduced rat liver was demonstrated in both larval and adult forms of the Hikone-R strain of Drosophila. A microsomal enzyme, it has many properties of a cytochrome P-450-containing mixed-function oxidase. Kinetic analysis indicates only a single enzyme with an apparent K/sub m/ of 10.5 mM DMN.

30558 **Cell-mediated mutagenicity in Chinese hamster V79 cells of dibenzopyrenes and their bay-region fluorine-substituted derivatives.** Hass, B.S. (Oak Ridge National Lab., TN); McKeown, C.K.; Sardella, D.J.; Boger, E.; Ghoshal, P.K.; Huberman, E. *Cancer Research;* **42**: 1646-1649(May 1982). Contract W-7405-ENG-26.

The polycyclic aromatic hydrocarbons dibenzo(a,i)pyrene and dibenzo(a,h)pyrene, each of which possesses two bay regions, and their bay-region difluorinated derivatives were tested for mutagenicity for ouabain and 6-thioguanine resistance in Chinese hamster V79 cells. Since V79 cells do not metabolize polycyclic aroma-

tic hydrocarbons, mutagenesis was tested in both the presence and the absence of golden hamster embryo cells capable of metabolizing polycyclic aromatic hydrocarbons. Neither of the dibenzopyrenes nor their fluorinated derivatives were mutagenic in the absence of the golden hamster embryo cells. In the presence of these cells (cell-mediated assay), both dibenzopyrenes were mutagenic, whereas the difluorinated derivatives, 2,10-difluorodibenzo(a,i)pyrene and 3,10-difluorobenzo(a,h)pyrene, either were inactive or exhibited (on a dose basis) a weak response. However, the mutagenicity of the dibenzopyrenes was eliminated when they were coincubated with 7,8-benzoflavone, a mixed-function oxidase inhibitor. The results suggest that metabolic oxidation of these polycyclic aromatic hydrocarbons at the bay region (presumably to diol-epoxides) is required for a mutagenic response in the cell-mediated assay.

30559 **Modulation of bleomycin cytotoxicity.** Moore, C.W. (Univ. of Rochester, NY). *Antimicrobial Agents and Chemotherapy;* **21**: No. 4, 595-600(Apr 1982). Contract AC02-76EV03490.

Lethal effects of a 75-μg/ml concentration (approximately 5 x 10^{-5} M) of bleomycin on stationary-phase haploid or diploid cells of the eucaryote Saccharomyces cerevisiae were negated in the presence of 0.05 M phosphate buffer (pH 7). High cell densities (2 x 10^8 cells per ml) further inhibited killing. Multiphasic survival curves resulting after treatments in deionized water (pH 6.7) suggested the presence of cells with differing susceptibilities either at the start of treatment periods or as a result of resistance which developed during exposure to antibiotic. To identify a delayed effect, prolonged lethal consequences of the action of bleomycin were investigated under liquid-holding conditions. Survival of untreated early-stationary-phase yeast cells was not significantly affected by incubation without antibiotic for 6 or 36 h in non-nutrient buffer or water. However, increased killing resulted after bleomycin-treated cells were incubated in the absence of bleomycin or buffer. Moreover, cells which had never been exposed to the antibiotic lost considerable colony-forming ability as a result of incubation with bleomycin-treated cells, indicating the efflux of bleomycin or a reaction product. The findings have implications for both experimental cell studies and cancer therapy, as well as for the chemical mechanisms by which a metal-bleomycin complex could cause killing.

30560 **Aspergillus nidulans: systems and results of tests for chemical induction of mitotic segregation and mutation. I. Diploid and duplication assay systems.** Kafer, E. (McGill Univ., Montreal, Canada); Scott, B.R.; Dorn, G.L.; Stafford, R. *Mutation Research;* **98**: 1-48(1982). Contract W-7405-ENG-26.

This review represents a critical summary of results from published investigations which analyze effects of chemicals on mitotic segregation in Aspergillus nidulans (covering mainly references of the period 1965-1978). On the basis of the test systems employed the evaluated publications fall into three groups. The first and largest group uses tests which identify effects of chemicals on the frequencies of homo- or hemizygous segregants in heterozygous diploids (14 papers). Such "segregants" arise from increased segregation, usually either by mitotic crossing-over, non-disjunction, malsegregation, or from semi-dominant mutations of various types, including lethals and chromosomal aberrations. The second group includes a few investigations which test for increases in the frequencies of recessive lethals or balanced translocations in treated diploids that are revealed by effects on the recovery of haploid second-order segregants (3 papers). The third group investigates effects on the frequencies of haploid sectors from duplication strains, that are affected by some chemicals and may be due to site-specific recombination or chromosome breakage (4 papers).

30561 **Operant behavior of rats exposed to lead before or after weaning.** Angell, N.F.; Weiss, B. (Univ. of Rochester, NY). *Toxicology and Applied Pharmacology;* **63**: 62-71(1982). Contract AC02-76EV03490.

Rats were exposed to lead (Pb) before or after weaning. For preweaning exposures, nursing dams received 0.2% Pb acetate(1090 ppm Pb) in drinking water. Offspring treated after weaning consumed the same concentration. Tapwater served as the control fluid. Pre-post treatments were distributed among four experimental groups of 10 rats each: tap water-tap water, Pb-tap water, tap water-Pb, Pb-Pb. Operant behavior training began on Postnatal Day 58. Animals performed on a multiple reinforcement schedule of food presentation consisting of fixed-interval, fixed-ratio, and time out components.Statistical analyses of experimental sessions 4 to 11 (Postnatal Days 72 to 79) revealed that postweaning exposure significantly lengthened the median interval (interresponse time) between consecutive responses on both the interval and ratio schedules. Preweaning exposure alone tended to produce a shortening of the median interresponse time. Other performance indices and subsequence variations of ratio size showed similar but not significantly different relationships among the treatment groups. No significant histopathology was detected. Brain and blood Pb concentrations were consistent with the treatment protocol.

30562 **Fetal distribution of mercury following introduction of methylmercury into porcine maternal circulation.** Kelman, B.J.; Walter, B.K.; Sasser, L.B. (Comparative Animal Research Lab., Oak Ridge, TN). *Journal of Toxicology and Environmental Health;* **10**: 191-200(1982).

Tissue samples were obtained from 115 swine fetuses from 10 litters and analyzed for tissue-bound Hg 24 h after mothers were exposed to low levels of methylmercury by iv injection. Absorption of Hg by the fetus and placenta increased throughout gestation in concert with increasing fetal weight, as did fetal hepatic Hg. Fetal renal Hg increased throughout gestation, but the increase appeared to be much greater than would be expected on the basis of weight increase alone. Blood Hg concentrations did not change significantly. Fetal brain Hg content and concentration increased dramatically toward the end of pregnancy, the gestational period during which the rate of brain growth is greatest in swine. The finding that a period of increased Hg concentration in brain corresponded with the period of maximal brain growth velocity is particularly interesting because of the hypothesis that the brain is especially sensitive to nutritional and, presumably, toxicological perturbation while it is growing most rapidly.

30563 **Acute and genetic toxicity of 1-nitropyrene and its fate after single oral doses to rats.** Marshall, T.C.; Royer, R.E.; Li, A.P.; Kusewitt, D.F.; Brooks, A.L. (Lovelace Inhalation Toxicology Research Inst., Albuquerque, NM). *Journal of Toxicology and Environmental Health;* **10**: 373-384(1982). Contract AC04-76EV01013.

The mammalian acute and genetic toxicity of 1-nitropyrene (NP) was studied because this and other nitroarenes are highly mutagenic toward bacteria and have been identified in emissions from combustion processes. A suspension of NP did not cause observable signs of acute toxicity and was not lethal when administered to male and female rats at single oral doses as high as 5.0 g/kg. Histological examination of stomach, intestine, lung, heart, spleen, pancreas, adrenal, and kidney from rats euthanized at 4 and 14 d after treatment revealed no detectable differences from control rats. Urine and feces were collected for 4 d after treatment with 5.0 g/kg. About 70% of the dose was present in the feces as NP, and about 2% was present as the reduced metabolite 1-aminopyrene (AP). Sulfate and glucuronide conjugates of AP were present in small amounts (<1%) in the urine, showing that at least some of the dose was absorbed. Bone marrow cells from female rats given NP orally at 0.5, 1.5, and 5.0 g/kg showed a slight dose-related increase in the frequency of sister chromatid exchanges. Both NP and AP showed low mutagenicity in Chinese hamster ovary cells in vitro. Evidence of reductive metabolism of NP in rats raises concern about the potential exposure of humans to this compound. However, the weak in vivo and in vitro genetic toxicity of NP at high dose levels in mammalian systems suggests that the potential hazard may not be as high as predicted from bacterial mutagenicity data.

30564 **Sister chromatid exchange, DNA repair, and single-gene mutation.** Carrano, A.V.; Thompson, L.H. (Lawrence Livermore National Lab., CA). *UCLA Symposia on Molecular and Cellular Biology, New Series;* 441-447(1982). Contract W-7405-ENG-48.

Sister chromatid exchange (SCE) has been studied in cultured mammalian cells with regard to the nature of the inducing lesion, mutation induction, and factors that modify the observed

frequency following mutagen exposure, SCEs can be induced by a wide spectrum of DNA lesions and, for nine agents examined, the frequency of induced SCE is linearly related to induced single-gene mutation. Further, a deficiency in DNA repair may alter the expression of both SCE and mutation in a qualitatively similar manner. The frequency of SCE induced by mitomycin-C is suppressed in heterochromatic relative to euchromatin and, in nondividing lymphocytes, the lesions leading to the formation of SCEs may persist for several months.

30565 **Food additives and environmental chemicals as sources of childhood behavior disorders.** Weiss, B. *Journal of the American Academy of Child Psychiatry;* **21**: 144-152(1982). Contract AC02-76EV03490.

The Feingold hypothesis postulates that many children who exhibit disturbed behavior improve on a diet devoid of certain food additives. Its validity has been examined on the basis of controlled trails. The total evidence, although not wholly consistent, nevertheless suggests that the hypothesis is, in principle, correct. Such a conclusion poses difficult problems and new issues for etiology, treatment, toxicology, and regulation.

30566 **In vitro cytotoxicity and genotoxicity of dibutyltin dichloride and dibutylgermanium dichloride.** Li, A.P.; Dahl, A.R.; Hill, J.O. (Lovelace Inhalation Toxicology Research Inst., Albuquerque, NM). *Toxicology and Applied Pharmacology;* **64**: 482-485(1982). Contract AC04-76EV01013.

The cytotoxicity and genotoxicity of dibutyltin dichloride (DBTC) and dibutylgermanium dichloride (DBGC) were studied with in vitro tests. DBTC was approximately 1000-fold higher in cytotoxicity and genotoxicity than DBGC. Both compounds decreased the antibody production by lymphocytes in vitro at noncytotoxic doses, which may explain the immunosuppressive effect of the compounds in vivo. Both compounds induced mutation in Chinese hamster ovary cells, therefore suggesting that they are potentially carcinogenic.

30567 **Distribution and retention of benzo(a)pyrene in rats after inhalation.** Mitchell, C.E. (Lovelace Biomedical and Environmental Research Inst., Albuquerque, NM). *Toxicology Letters;* **11**: 35-42(1982). Contract AC04-76EV01013.

Tritium levels in tissues of rats were determined after inhalation of tritiated benzo(a)pyrene (^{3}H-BaP; 500 μg/1; activity mass median diameter, 1-2 μm) for 1 h. Significant amounts of radioactivity were found in the nasal turbinates, trachea, larynx, lungs, tracheobronchial lymph nodes, kidneys, and liver immediately after exposure. Lower concentrations of radioactivity were found in the brain, testes, and spleen. Clearance of radioactivity from the respiratory tract occurred in two phases; a rapid phase where 50% of the radioactivity cleared by ~ 2 h, and a slower phase that continued for about 2 days after exposure. Radioactivity in the brain, testes, and spleen remained at about the same level during the first day after exposure and then decreased slightly during the second day. Benzo(a)pyrene inhaled in this particulate form was rapidly solubilized, translocated to internal organs, and excreted primarily in feces.

30568 **Deposition, retention, and biological fate of inhaled benzo(a)pyrene adsorbed onto ultrafine particles and as a pure aerosol.** Sun, J.D.; Wolff, R.K.; Kanapilly, G.M. (Lovelace Biomedical and Environmental Research Inst., Albuquerque, NM). *Toxicology and Applied Pharmacology;* **65**: 231-244(1982). Contract AC04-76EV01013.

The effect of ultrafine, airborne, carrier particles on the deposition, retention, and biological fate of inhaled polycyclic aromatic hydrocarbons (PAHs) was studied. Using a radiolabeled model PAH, [^{3}H]benzo(a)pyrene ([^{3}H]BaP), Fischer-344 rats were exposed by nose-only inhalation (30 min) to this compound, as a coating (15% by mass) on insoluble $^{67}Ga_2O_3$ particles or as a pure aerosol. These aerosols were produced by vapor condensation methods in a dynamic aerosol generation system. The concentrations of [^{3}H]BaP in the coated and homogeneous aerosols were 0.6 and 1.0 μg/liter of air, respectively, while the mass median diameter of both these aerosols was approximately 0.1 μm. Pulmonary retention of ^{3}H radioactivity was longer in animals exposed to the [^{3}H]BaP coated on the $^{67}Ga_2O_3$ particles. The time required to clear 90% of the initial lung burden of $^{67}Ga_2O_3$-associated ^{3}H radioactivity detected 30 min postexposure was approximately 1 day as compared to 4 hr for animals ex Tracheal clearance of 90% of the $^{67}Ga_2O_3$-associated ^{3}H radioactivity required 1 day, while only 1.5 hr were required to clear the same percentage of ^{3}H radioactivity from the tracheas of rats exposed to the pure [^{3}H]BaP aerosol. The rates of clearance of this ^{3}H material to other tissues suggested that a substantial amount of the [^{3}H]BaP coated on $^{67}Ga_2O_3$ was cleared from lungs by mucociliary clearance and subsequent ingestion, whereas the majority of the pure [^{3}H]BaP aerosol was cleared by direct absorption into blood. In both cases, the ultimate fate of the majority of the [^{3}H]BaP and its metabolites was excretion in feces.

30569 **Benzo[a]pyrene metabolites: formation in rat liver cell-culture lines, binding to macromolecules, and mutagenesis in V79 hamster cells.** Selkirk, J.K.; MacLeod, M.C.; Kuroki, T.; Drevon, C.; Piccoli, C.; Montesano, R. (Oak Ridge National Lab., TN). *Carcinogenesis (New York);* **3**: No. 6, 635-639(1982). Contract W-7405-ENG-26.

Benzo[a]pyrene was metabolized in liver cell lines derived from BD-IV and BD-VI rats which included several chemically-transformed lines (IAR-6-1; IAR-19; IAR-28), one spontaneous transformant (IAR-27) as well as one nonmalignant line (IAR-20). Cultures were treated with tritiated benzo[a]pyrene over a 5-day period. The cells and medium were extracted with ethyl acetate and the distribution between organic-soluble and water-soluble metabolites determined. Organic-soluble metabolites consisting of dihydrodiols, phenols and quinones were determined by high-pressure liquid chromatography, and macromolecular binding of BP to each cell line was measured over a 24-h period. Comparisons between binding and overall metabolism were not directly proportional in these liver cell lines. However, there was a positive correlation for benzo[a]pyrene mutagenesis in the V-79 hamster cell assay with 8-azaguanine as a marker when the cell lines with the highest (IAR-20) and lowest (IAR-27) metabolic competence were used as activating cell layers.

30570 **Time course of metabolish of benzo[e]pyrene by hamster embryo cells and the effect of chemical modifiers.** Macleod, M.C.; Mansfield, B.K.; Selkirk, J.K. (Oak Ridge National Lab., TN). *Chemico-Biological Interactions;* **40**: 275-285(1982). Contract W-7405-ENG-26.

In cultures of hamster embryo cells, benzo[a]pyrene(B[a]P) is metabolized promarily in the bay region. In contrast, little or no bay region metabolism of the noncarcinogenic isomer benzo[e]pyrene (B[e]P) could be detected during 12 to 96 h incubations of hamster embryo cells with 4μM[^{3}H]B[e]P: The upper limit to 9,10-dihydro-9,10-dihydroxy-B[e]P formation is about 0.2% of the ethyl acetate-soluble metabolites)<0.1% of the total metabolites). The major identified metabolites of B[e]P were 4.5-dihydro-4,5-dihydroxy B[e]P and the glucuronide conjugates of 3-OH-B[e]P and 4,5-dihydro-4,5-dihydroxy B[e]P. Simultaneous treatment of cells with either B[a]P or 7,8-benzoflavone (BF) did not induce bay region metabolism of [^{3}H]B[e]P.

30571 **Cytochrome P-450 dependent monooxygenase activity in rat nasal epithelial membranes.** Hadley, W.M.; Dahl, A.R. (Inhalation Toxicology Research Inst., Albuquerque, NM). *Toxicology Letters;* **10**: 417-422(1982). Contract AC04-76EV01013.

Cytochrome P-450 was found in nasal epithelial membranes (NEM) of the rat. The quantity was 12% that of liver on a per mg of microsomal protein basis and 1.6 times that of the lung on the same basis. Metabolism of p-nitroanisole was faster by microsomes from NEM than by microsomes from liver or lungs while the metabolism rate of aniline by microsomes from NEM was between that of microsomes from liver and lung.

30572 Acute toxicity of polyethylene glycol p-isooctylphenol ether in Syrian hamsters exposed by inhalation or bronchopulmonary lavage. Damon, E.G. (Inhalation Toxicology Research Inst., Albuquerque, NM); Halliwell, W.H.; Henderson, T.R.; Mokler, B.V.; Jones, R.K. *Toxicology and Applied Pharmacology;* **63**: 53-61(1982). Contract AC04-76EV01013.

Dose-response studies were conducted with Syrian hamsters exposed to polyethylene glycol p-isooctylphenyl ether (Triton X-100) via inhalation or bronchopulmonary lavage. Syrian hamsters were exposed to an aerosol of Triton X-100 with a mass median aerodynamic diameter of 1.5 μm and a concentration of 3.0 mg/liter. Estimated initial lung burdens of Triton X-100 ranged from 800 to 3100 μg. Hamsters were lavaged with concentrations of Triton X-100 ranging from 0.01 to 0.10% in isotonic saline resulting in initial lung burdens of Triton X-100 that ranged from 300 to 3200 μg. The LD50/7 values were 1700 μg (1300 to 2100 μg, 95% confidence limits) for the inhalation study and 2100 (1900 to 2700) μg for the lavage study. The difference between the LD50/7 values for the two methods of exposure was not significant. However, histopathological examination revealed differences in the nature and distribution of pathologic changes observed in animals exposed by the two routes of administration. Animals exposed by inhalation died as a result of ulcerative laryngitis and laryngeal edema with only minimal pulmonary pathologic alterations. Animals exposed by lavage, where the larynx was not exposed to Triton X-100, died from pulmonary edema and acute exudative pneumonia. These results demonstrate the need for careful selection of exposure methods to meet the specific objectives of a toxicology study.

30573 In vivo sister-chromatid exchange assay in the larvae of the mussel Mytilus edulis; response to 3 mutagens. Harrison, F.L.; Jones, I.M. (Lawrence Livermore National Lab., CA). *Mutation Research;* **105**: 235-242(1982). Contract W-7405-ENG-48.

An in vivo sister-chromatid exchange (SCE) assay using the larvae of the mussel Mytilus edulis was developed. Larvae were exposed to mutagens beginning 12 h after fertilization and harvested 12 h later in the late trochophore stage. Dose responses to the mutagens bromodeoxyuridine, mitomycin C and methyl methanesulfonate were linear. The sensitivity of the SCE response of mussel larvae to these mutagens compares favorably with that of other systems and indicates this assay to be valuable in marine genetic toxicological monitoring.

30574 Dissolution half-times of nickel compounds in water, rat serum, and renal cytosol. Kuehn, K.; Sunderman, F.W. Jr. (Univ. of Connecticut School of Medicine, Farmington). *Journal of Inorganic Biochemistry;* 1-11(1982). Contract AC02-76EV03140.

Seventeen nickel compounds were incubated in water, rat serum, and rat renal cytosol for 72 hr at 37°C. Concentrations of dissolved nickel were analyzed by electrothermal atomic absorption spectrophotometry, and dissolution half-times (T50) were computed by the Weibull equation. Eleven of the nickel compounds (Ni, βNiS, amorphous NiS, αNi_3S_2, NiSe, Ni_3Se_2, NiTe, NiAs, $Ni_{11}As_8$, Ni_5As_2, and $NiFeS_4$) dissolved more rapidly in serum or cytosol than in water. Four of the compounds (NiO, NiSb, NiFe alloy, and $NiTiO_3$) had no detectable dissolution in any of the media (i.e., T50 > 11 yr). One compound (NiAsS) had approximately equal T50 values in the three media; the T50 value of one compound (NiS_2) could not be determined in serum or cytosol owing to precipitation. T50 values of 34 and 21 days for dissolution of αNi_3S_2 in serum and cytosol, respectively, agree closely with the excretion half-time of 24 days derived from previously reported data for excretion of ^{63}Ni in urine and feces of rats after intramuscular injection of $\alpha^{63}Ni_3S_2$. These findings suggest that in vitro dissolution half-times of nickel compounds may be used to predict their in vivo excretion half-times, since the dissolution process is rate-limiting to their metabolism and excretion.

30575 Mutagenicity of 4,4'-methylenedianiline derivatives in the Salmonella histidine reversion assay. Rao, T.K. (Oak Ridge National Lab., TN); Dorsey, G.F.; Allen, B.E.; Epler, J.L. *Archives of Toxicology;* **49**: 185-190(1982). Contract W-7405-ENG-26.

4,4'-Methylenedianiline and its derivatives were assayed for mutagenicity in the Salmonella/microsomal mutagenicity assay developed by Ames. A specificity to revert strain TA98 suggests a mechanism of frameshift mutagenesis. Liver microsomal preparations from rats induced with phenobarbital were most effective for metabolic activation. Alkyl substitution of 4,4'-methylenedianiline did not alter its mutagenic activity; however, substitution of both positions ortho to the amino group eliminated mutagenic activity. Substitutions with alkoxy-carbonyl groups eliminated mutagenic activity, whereas halogen substitution enhanced the mutagenic activity. The results presented here show the use of structure-activity studies as predictive tools for the assessment of genotoxic properties of industrial chemicals.

30576 Effects of copper on the latency of lysosomal hexosaminidase in the digestive cells of Mytilus edulis. Harrison, F.L.; Berger, R. (Lawrence Livermore National Lab., CA). *Marine Biology (Berlin);* **68**: 109-116(1982). Contract W-7405-ENG-48.

Mytilus edulis collected from Tomales Bay, California, USA, during mid-winter 1979 were exposed to increased concentrations of dissolved copper under controlled laboratory conditions. A dose-dependent reduction in the latency of lysosomal hexosaminidase activity in digestive cells was induced after a 30 d exposure to copper. The half-time of the hexosaminidase staining reaction in sections of digestive gland from control mussels was 15.5 min; for mussels exposed to 25, 50, and 75 μg Cu l^{-1} it was 11.8, 8.5, and 5.5 min, respectively. In addition, the dye-coupled reaction product was seen earlier in sections from individuals exposed to 50 and 75 μg Cu l^{-1} (after 30 s) and 25 μg Cu l^{-1} (1 min) than in sections from control individuals (2.5 min). Copper accumulations were demonstrated histochemically to have the same distribution as the hexosaminidase reaction product, indicating that copper is sequestered in lysosomes. Copper concentrations in digestive gland tissue were related to the concentrations of copper in the water to which the mussels were exposed.

30577 Mutagenic and toxic activity of environmental effluents from underground coal gasification experiments. Timourian, H.; Felton, J.S.; Stuermer, D.H. (Lawrence Livermore National Lab., CA). *Journal of Toxicology and Environmental Health;* **9**: 975-994(1982). Contract W-7405-ENG-48.

Using bacterial bioassays, researchers have screened for the presence of mutagens and toxins in extracts from groundwater, and in tar from product gas, at the sites of two Lawrence Livermore National Laboratory (LLNL) in situ experiments: Hoe Creek II and Hoe Creek III. The sites exhibited different potential biological hazards, suggesting that different gasification processes may represent different human health concerns. Researchers found that mutagens are present in groundwater, persist for at least 2 yr after gasification has been terminated, and show a change in activity with time - possibly in parallel with changes in chemical composition. Preliminary evidence suggests that the mutagens in groundwater are quinoline and aniline derivatives, while the toxins in groundwater may be phenolic compounds. In tar from the product gas, the organic bases and neutrals were found to be genotoxic in both bacterial and mammalian cells; the neutral compounds appear to be the major mutagenic health hazards. Neutral compounds constitute most of the tar (85 to 97 wt %) and were mutagenic in both the bacterial and mammalian cell assays. Tar in the gas stream may be a problem for the aboveground environment if gas escapes through fractures in the overburden. Because it is mutagenic and induces chromosomal damage to mammalian cells, the tar may represent a disposal problem as well. However, it is difficult to assess tar quantitatively as a health hazard because its mutagenic activity is low, possibly due to contaminants in the neutral fraction that act to suppress mutagenicity.

30578 Structure-toxicity relationships of selected nitrogenous heterocyclic compounds II. Dinitrogen molecules. Schultz, T.W. (Oak Ridge National Lab., TN); Cajina-Quezada, M. *Archives of Environmental Contamination and Toxicology;* **11**: 353-361(1982). Contract W-7405-ENG-26.

Thirteen dinitrogen-containing cyclic compounds were examined to determine the relationship between selected structural and physicochemical parameters and impairment to population growth of the common ciliate Tetrahymena pyriformis. Under static conditions all compounds tested are persistent in aqueous solution. Both an increase in methyl substitution and an increase in the number of aromatic rings per compound result in increased growth impairment. Linear positive relationships exist between the log biological response values of the alkyl analog set and each of four hydrophobic indexes: number of carbon atoms, molecular weight, boiling point, and the log of the 1-octanol/water partition coefficient. No such relationships were found for isomers, for which the crowding of ring-substituted nitrogen has no effect on the number of carbon atoms and molecular weight but causes an increase in boiling point and biological response and a decrease in 1-octanol/water partition coefficient. In addition, linear positive correlations were demonstrated between the log of the absolute value of the slope of the population growth impairment equation of the alkyl analog set and each of the four hydrophobic parameters. Comparisons of log 1-octanol/water partition coefficients with log biological response or log slope of mononitrogen-substituted cyclic compounds show that similar correlations exist for both mono- and dinitrogen substitution.

30579 **Comparative structure-genotoxicity study of three aminoanthraquinone drugs and doxorubicin.** Au, W.W.; Butler, M.A.; Matney, T.S.; Loo, T.L. (Univ. of Texas, Houston). *Cancer Research;* **41**: 376-379(Feb 1981).

Two aminoanthraquinone analogs 1,4-bis[2-[(2-hydroxyethyl)amino]ethylamino)-9,10-anthracenedione (HAQ) and 1,4-dihydroxy-5,8-bis(2-[(2-hydroxyethyl)amino]amino]ethylamino]-9,10-anthracenedione (DHAQ) have been shown to possess similar therapeutic activities against experimental tumors but different toxicities to the animals. In this study, the genotoxic effects of these two drugs and a new analog, 1,4-dihydroxy-5,8-bis(2-[(2-hydroxethyl)amino]ethylamino]-9,10-anthracenedione diacetate, were analyzed by using mammalian cell cytogenetic assays (chromosome breakage and sister chromatid exchanges) as well as bacterial mutagenesis assays. The experimental therapeutic activities of these drugs in vivo correlated well with their in vitro genetic toxicities as revealed by cytogenetic assays. DHAQ was also more genotoxic than Adriamycin. In cytogenetic assays, the activities of all drugs were reduced to different degrees in the presence of a S-9 metabolic system. Discrepancies were observed between results obtained from cytogenetic assays and those from mutagenesis assays. Whereas DHAQ was most active in cytogenetic studies, Adriamycin was most mutagenic or toxic. HAQ was least active cytogenetically, and this activity was not changed appreciably in the presence of metabolic enzymes. However, it was metabolically activated to a bacterial mutagen.

5604 Other Environmental Pollutant Effects

REFER ALSO TO CITATION(S) 29527

30580 **(AD-A—122690/1) Basal body and striated rootlet changes in primate macular retinal pigmented epithelium after low level diffuse argon laser radiation. Final report 1981-1982.** Schuschereba, S.T.; Zwick, H.; Stuck, B.E.; Beatrice, E.S. (Letterman Army Inst. of Research, San Francisco, CA (USA)). Sep 1982. 22p. NTIS, PC A02/MF A01.

Basal bodies or centrioles (BB - microtubule organizing centers) and striated rootlets (SR - bundles of 60 A action-like filaments) have a close association in primate retinal pigmented epithelial (RPE) cells. The frequency of occurrence of these structures was evaluated in the macular RPE after repeated exposure to low level diffuse argon laser radiation (DALR). The awake chaired animal's head was restrained and positioned near the center of the 0.75 m hemisphere which was diffusely irradiated with 514.5 nm laser radiation. The right eye of each subject was occluded during the two-hour exposure session. The first subject received 24 cumulative hours of exposure, the second, 40 hours and the third, 42 hours.

30581 **(AD-A—122728/9) Annual research progress report, FY 1980. Annual report 1 Oct 79-30 Sep 80.** Marshall, J.D. (Letterman Army Inst. of Research, San Francisco, CA (USA)). 1 Oct 1980. 222p. NTIS, PC A10/MF A01.

During Fiscal Year 1980 progress was attained at the Letterman Army Institute of Research in the following research areas: Basic and applied studies on blood, blood products and blood substitutes; physiology of hemorrhagic shock, pharmacological intervention of shock; the determination of coherent radiation exposure thresholds causing damage to the eye, definition and treatment for laser injuries of the skin and eye; military stress and combat effectiveness; evaluation and toxicology of insect repellents; defense against chemical agents. The progress made in this fiscal year is described in the reports of the work units presented.

30582 (LA—9479-PR, pp 112-115) **Potassium ion influx measurements on cultured Chinese hamster cells exposed to 60-hertz fields.** Stevenson, A.P.; Tobey, R.A. Oct 1982. NTIS, PC A08/MF A01.

In Los Alamos Life Sciences Division's biomedical and environmental research programs. Progress report, January-December 1981.

Studies of the effects of 60-Hz electromagnetic fields (ELF) on the growth and survival of cultured Chinese hamster (line CHO) cells showed that cell growth over prolonged time periods is not affected by fields up to 2.85 V/m. These findings led to the search for a more sensitive parameter for measuring effects of such fields on cellular processes. The study of potassium ion influx was considered to be of particular importance in view of both the role of potassium ions in protein synthesis, a process necessary for cell growth and suvival, and the fact that the pumps responsible for transport of this ion into the cell are electrogenic, and therefore, perhaps sensitive to the effects of impinging fields. Additionally, measurement of K^+ influx in cultures of CHO cells exposed to hyperthermia (42°C) had demonstrated previously that changes in transport could be measured immediately (as early as one minute after treatment). Therefore, it was decided to investigate in CHO cells the effects of 60-Hz fields on K^+ influx.

30583 **(PB—83-155747) Nonionizing radiation 583.** (National Inst. for Occupational Safety and Health, Cincinnati, OH (USA)). Apr 1977. 574p. NTIS, PC A24/MF A01.

This document presents an introductory course on nonionizing radiation intended for industrial hygienists, health physicists, and other professional health personnel. Topics covered in the course include nonionizing radiation sources, the attendant hazards to personnel, and the basic principles of radiation control. The importance of evaluation and control of laser and microwave radiation sources is stressed. Course objectives are to enable the student to identify a nonionizing radiation source and the radiation emitted, determine the degree of hazard to exposed personnel, and to apply the necessary protective procedures to reduce or eliminate the hazard.

30584 **Effects of 60-Hz electric fields on specific humoral and cellular components of the immune system.** Morris, J.E.; Phillips, R.D. (Pacific Northwest Lab., Richland, WA). *Bioelectromagnetics (New York);* **3**: 341-347(1982). Contract AC06-76RL01830.

Humoral and cellular functions of the immune system of Swiss-Webster mice were evaluated after exposure to 60-Hz electric fields at 100 kV/m. No significant differences were observed in primary antibody response to keyhole limpet hemocyanin (precipitating antibody levels) between exposed (30 or 60 days) and control mice, nor were there significant changes in mitogen-stimulation response of spleen cells from mice similarly exposed for 90 or 150 days when compared to sham-exposed animals.

30585 **The influence of radiofrequency/microwave energy absorption on physiological regulation.** Michaelson, S.M. (Univ. of Rochester, NY). *British Journal of Cancer;* **45**: No. Suppl. V., 101-107(1982). Contract AC02-76EV03490.

Physiological regulation represented by thermoregulation, neuroendocrine function, neurochemical activity, and immune responses is a composite of exquisitely "tuned" interrelated systems

that constitute sensitive indicators of body responses to environmental stimuli or absorbed physical energies. Exposure to microwave/radiofrequency fields may affect such physiological regulation. Study of the integration and correlation of many body functions relative to the altered homoeostatic status of the microwave/radiofrequency-exposed subject is thus indicated. Microwave-induced physiological changes cannot be dissociated from increases in tissue temperature. Such responses are considered to be essential in defence against environmental changes as a febrile response is essential for host immune defence. These responses can also be considered to reflect the utilization of physiological function to maintain regulations or adjustments. These are not necessarily adverse reactions to environmental stimuli. These responses can be transient or persistent, beneficial or detrimental. Assessment of the integration and correlation of these functions relative to the thermal inputs and homoeokinetic reactions of the individual subjected to microwave/radiofrequency energy should permit differentiation between potential hazards which might compromise the individual's ability to maintain normal physiological function and effects which are compensated by physiological redundancy.

57 HEALTH AND SAFETY

30586 **(UCID—19758) Contingency plan for the Lawrence Livermore National Laboratory, Site 300, hazardous waste operations.** Gonzalez, M.A. (Lawrence Livermore National Lab., CA (USA)). 1 Apr 1983. Contract W-7405-ENG-48. 26p. NTIS, PC A03/MF A01. Order Number DE83010176.

This contingency plan for hazardous waste release provides guidance for coordinating response efforts. With a goal to minimize hazards to human health and life; and protect livestock, wildlife, the environment, and property in the event of a fire, explosion, or any unplanned release of hazardous substances or mixtures to the air, water, or soil. In this document, hazardous waste includes all waste substances or mixtures that: contain any of the hazardous substances listed in the Resource Conservation and Recovery Act; have the characteristic of being toxic, flammable, reactive, corrosive, an irritant, and/or a strong sensitizer; are radioactive and are used in experiments at Site 300; or could have a significant effect on the environment. This Plan includes an overview of emergency response capabilities; and responsibilities assigned to both LLNL and non-LLNL emergency response personel. (PSB)

58 GEOSCIENCES

5801 Geology And Hydrology

REFER ALSO TO CITATION(S) 29058, 29059, 29096, 29097, 29133, 29134, 29140, 29157, 29162, 29240, 29242, 30371, 30391

30587 **(DOE/ET/12138—1275) Techniques and tests for measuring joint intensity.** Dixon, J.M. (West Virginia Univ., Morgantown (USA). Dept. of Geology and Geography). Dec 1979. Contract AC21-76ET12138. 148p. NTIS, PC A07/MF A01. Order Number DE83009587.

Anomalous intense jointing has been cited as a reason for gas production from fractured shales, coal mine roof falls, some construction problems, and increased water-well yields. The Parsons lineament in West Virginia, was chosen to develop and test field and analytical methods for measuring joint intensity. Rocks of the Middle and Upper Devonian Chemung Group and Catskill Formation, and the Mississippian Pocono Formation along the Allegheny Front, were studied to determine how the fracturing effects of the Petersburg lineament varies with depth and with different lithologies. In the Plateau province, rocks of the Lower and Middle Pennsylvanian Pottsville Group and Allegheny Formation were measured to determine the westward extent of the lineaments. A large roadcut in northern West Virginia was chosen to study the effects of a stream channel on coal cleat intensities. Joint spacing was found to be the only necessary measurement, other than strike and dip, to determine joint intensity. Rocks inside the Parsons and Petersburg lineaments were found to be more intensely jointed than rocks adjacent to the lineaments. Along the Allegheny Front, the Petersburg lineament affects rock at least one half mile below ground level. Farther west in the Plateau province, joint intensities measured indicate that the high-intensity joint systems of the Parsons and Petersburg lineaments are disrupted or terminated. Air photograph and LANDSAT lineaments may be an aid in locating structural lineaments or areas of intense jointing, but do not necessarily define or bound such areas.

30588 **(DOE/SR/01072—8) Geomorphic history of a portion of the Savannah River flood plain, Barnwell County, South Carolina.** Stevenson, A.E. (South Carolina Univ., Columbia (USA). Dept. of Geology). 1982. Contract AS09-78SR01072. 269p. NTIS, PC A12/MF A01. Order Number DE83009014.

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As a result of an intensive archeological survey undertaken on the Plant, the Savannah River Valley has become the focus of an effort to tie the history of the Savannah River with cultural trends observed in the surrounding highlands. The flood-plain swamp contains well-preserved remnant sedimentologic evidence of former Savannah River occupations. This study utilizes geomorphic detail obtained from low level infra-red aerial photographs of the Savannah River flood plain in the area to interpret and distinguish various types of alluvial depositional environments. Relative temporal succession of the Savannah River across the modern (Holocene) valley floor is determined by evaluation of fluvial trends and their cross-cutting relationships. Sampling of sedimentary deposits for general alluvial stratigraphy and radiocarbon dating of plant detritus determine geomorphic trends and their absolute temporal relationships.

30589 **(NUREG/CP—0030) Symposium on unsaturated flow and transport modeling.** Arnold, E.M.; Gee, G.W.; Nelson, R.W. (eds.). (Pacific Northwest Lab., Richland, WA (USA)). Sep 1982. Contract AC06-76RL01830. 330p. (CONF-820364—; PNL-SA—10325/P). NTIS, PC A15/MF A01 - GPO $9.00. Order Number DE83001612.

From Symposium on unsaturated flow and transport modeling; Seattle, WA, USA (23 Mar 1982).

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This document records the proceedings of a symposium on flow and transport processes in partially saturated groundwater systems, conducted at the Battelle Seattle Research Center on March 22-24, 1982. The symposium was sponsored by the US Nuclear Regulatory Commission for the purpose of assessing the state-of-the-art of flow and transport modeling for use in licensing low-level nuclear waste repositories in partially saturated zones. The first day of the symposium centered around research in flow through partially saturated systems. Papers were presented with the opportunity for questions following each presentation. In addition, after all the talks, a formal panel discussion was held during which written questions were addressed to the panel of the days speakers. The second day of the Symposium was devoted to solute and contaminant transport in partially saturated media in an identical format. Individual papers are abstracted.

30590 (NUREG/CP—0030, pp 3-34) **Recent developments in modeling variably saturated flow and transport.** Lappala, E.G. (Ertec Western, Inc., Long Beach, CA). Sep 1982. NTIS, PC A15/MF A01 - GPO $9.00.

From Symposium on unsaturated flow and transport modeling; Seattle, WA, USA (23 Mar 1982).

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Analysis of the movement of liquid and gaseous contaminants through variably saturated porous media under field situations is increasingly being required as part of the design and siting of waste-disposal facilities. Simulation of mass and energy transport in variably saturated media has increased recently because of the development of numerical and quasianalytic solution methods and computer codes to solve the nonlinear, coupled transport equations. Numerical models are available to solve a wide range of multi-dimensional, multiphase transport problems. Most numerical difficulties have been addressed in a satisfactory manner by the use of appropriate methods for spatial and temporal discretization, linearization and matrix solution. However, cetain aspects of transport under variably saturated conditions presently make routine application of models to field problems difficult. These are currently being

addressed and include: (1) incomplete theory of transport processes are exemplified by transport in multidimensional, multiple porosity systems; (2) difficulty and expense of in situ determination of the nonlinear transport parameters; (3) inadequate understanding of the spatial variability of transport parameters, particularly for natural, non-agricultural situations; and (4) difficulty in simulating phenomena having a wide range of required temporal and spatial detail. Modeling of unsaturated flow and transport is discussed in the context of present capabilities and those areas in which effort is needed to assure consistent methodologies for simulating problems in the detail required for planning and design of waste-disposal facilities. 100 references.

30591 (NUREG/CP—0030, pp 35-53) **Unsaturated flow modeling as applied to field problems.** Segol, G. (Bechtel Civil and Minerals, Inc., San Francisco, CA). Sep 1982. NTIS, PC A15/MF A01 - GPO $9.00.

From Symposium on unsaturated flow and transport modeling; Seattle, WA, USA (23 Mar 1982).

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Ground-water flow models have proved to offer significant advantages over more traditional methods of analysis in most nontrivial problems. Models appear particularly helpful for field-scale applications when most of the assumptions on which analytical solutions are based, such as material homogeneity, one-dimensionality, and regular geometry, cannot be justified. In the case of saturated flow, there exists many successful field-scale simulations. In the case of unsaturated flow, however, the use of models is complicated by several problems including mesh selection and the lack of data in the unsaturated zone. The purpose of this paper is thus to discuss some of the questions to be resolved when applying unsaturated flow models to field-scale simulations. Two case studies are used to illustrate the discussion: one deals with the analysis of flow through a pile of solid waste materials produced by a coal-burning utility; the other deals with the analysis of potential seepage at the site of a proposed coal gasification plant.

30592 (NUREG/CP—0030, pp 55-75) **Coupled heat and moisture transport in unsaturated soils.** Childs, S.W. (Oregon State Univ., Corvallis). Sep 1982. NTIS, PC A15/MF A01 - GPO $9.00.

From Symposium on unsaturated flow and transport modeling; Seattle, WA, USA (23 Mar 1982).

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It has long been recognized that heat and moisture transport are coupled in porous media. Coupled transport effects on water flow are of importance in near surface agricultural situations. The theory will also be very important for applications involving either storage or disposal of thermal energy in porous media. The value and limitations of the most commonly used formulation of coupled transport theory is reviewed here. Also the effect of temperature on transport coefficients is demonstrated and example properties are given for several soil materials.

30593 (NUREG/CP—0030, pp 77-93) **Influence of climatic parameters on movement of radionuclides in a multilayered saturated-unsaturated media.** Gureghian, A.B. (Battelle Office of Nuclear Waste Isolation, Columbus, OH). Sep 1982. NTIS, PC A15/MF A01 - GPO $9.00.

From Symposium on unsaturated flow and transport modeling; Seattle, WA, USA (23 Mar 1982).

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A numerical analysis of the influence of climatic parameters on the movement of a typical radionuclide, Ra-226, in the profile of an inactive uranium mill tailings impoundment is reported. Two scenarios of meteorological events assumed to characterize the lower and upper bounds of potential Ra-226 migration rates are investigated. The first duplicates the true climatological conditions prevailing at the site of interest where evaporation is in excess of rainfall. The second is a hypothetical case in which the annual evaporation balances the rainfall. The fluctuations over time of these surface fluxes are simulated by simple harmonic functions. The model is composed of two modules: The first to calculate the pressure distribution in the domain of interest, enabling one to compute the velocities and soil moisture; the second to calculate the migration of the various species by taking into account all the major processes associated with the transport phenomena of a dissolved substance in porous media, i.e., advection, mechanical dispersion, molecular diffusion, radioactive decay and sorption (assuming a linear equilibrium isotherm). The numerical method of solving the one-dimensional transport of water and Ra-226 in the non-homogeneous soil system under saturated-unsaturated and isothermal conditions as adopted here is the finite-element method based on the weighted residual techniques. The flow equation is solved by the Bubnov-Galerkin method in which the weighting functions are identical to the linear basis functions. The solute equation is solved by a Petrov-Galerkin type method in which the convective and dispersive terms are weighted with asymmetric quadratic functions yielding an upstream weighting of the convection term. A test case involving the movement of a non-reacting ionic species in an actual field experiment is used to validate the model.

30594 **(PB—82-255589) Perspectives in geology. Circular 525.** (Illinois State Geological Survey, Champaign (USA)). 1982. 68p. (CONF-8010132—). NTIS.

From 75th anniversary of the Illinois State Geological Survey symposium; Urbana, IL, USA (9 Oct 1980).

The papers in this symposium present diverse perspectives in geology, mineral resources, paleontology, and environmental concerns. Papers within the scope of EDB have been entered individually into the data base. (ACR)

30595 **(RHO-BW-CR—133P) Report on geologic remote sensing of the Columbia Plateau.** Sandness, G.A.; Kimball, C.S.; Schmierer, K.E.; Lindberg, J.W. (Pacific Northwest Lab., Richland, WA (USA)). May 1982. Contract AC06-77RL01030. 360p. (PNL—3140). NTIS, PC A16/MF A01. Order Number DE83010201.

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The purpose of this remote sensing study is to identify faults or other geologic features which may have a significant bearing on the structural and tectonic character of the Hanford Site and the surrounding region. Landsat imagery, Skylab photographs, and U-2 photographs were analyzed to identify and map geologic photolineaments in the Columbia Plateau. The Landsat and Skylab imagery provided a regional perspective and allowed the identification of large-scale linear features. The U-2 photography provided much greater spatial resolution as well as a stereoscopic viewing capability. This allowed identification of smaller structural or geologic features and the identification of many cultural and nongeologic lineaments detected in the Landsat and Skylab imagery. The area studied totals, approximately 85,000 square miles, and encompasses virtually all exposures of Columbia River Basalt in the states of Washington, Oregon, and Idaho. It also includes an area bordering the Columbia River Basalt outcrop. This border area was studied in order to identify significant structures that may extend into the plateau. Included are a description of the procedures used for image analysis, 20 lineament maps at a scale of 1:250,000, geological summaries for the areas covered by the lineament maps, and discussions of many of the lineaments shown on the maps. Comparisons of the lineament maps with available geologic maps showed that the number of detected lineaments was much greater than the number of known faults and other linear features. Approximately 70% of the faults shown on the geologic maps were detected and are characterized as lineaments. Lineament trends in the northwest-southeast and northeast-southwest directions were found to predominate throughout the study area.

30596 **(SAND—79-0271) Basic data report for Drillhole ERDA 10 (Waste Isolation Pilot Plant - WIPP).** (Sandia National Labs., Albuquerque, NM (USA); D'Appolonia Consulting Engineers, Albuquerque, NM (USA)). Feb 1983. Contract AC04-76DP00789. 179p. NTIS, PC A09/MF A01. Order Number DE83010296.

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Borehole ERDA 10 was drilled to obtain information on possible dissolution of halite within the Castile Formation and on the hydrologic characteristics of the fluid-bearing zones in the Bell Canyon Formation. The borehole is located in Section 34, T23S,R30E in southern Eddy County, New Mexico. ERDA 10 was drilled to a depth of 4431.5 ft. Cores from the Castile were taken to obtain direct information which was supplemented by geophysical

logging. Based on preliminary analysis of the data, the ERDA 10 stratigraphic section is interpreted as a sequence of sandstones, siltstones, claystones, and evaporites normal for the area. No evidence of dissolution of significant amounts of halite was observed.

30597 **(SAND—83-0210) Hydrogeochemical parameters of fluid-bearing zones in the Rustler and Bell Canyon formations: Waste Isolation Pilot Plant (WIPP), southeast New Mexico (SENM).** Gonzalez, D.D. (Sandia National Labs., Albuquerque, NM (USA)). Mar 1983. Contract AC04-76DP00789. 33p. NTIS, PC A03/MF A01. Order Number DE83010418.

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The data contained herein are a compilation of hydrogeochemical information collected by the US Geological Survey and Sandia National Laboratories in support of the proposed WIPP facility. These data have been collected as a result of field operations ongoing since 1976 and are a result of extensive observations made at 24 locations. Hydraulic testing, chemical analysis, and geophysical logging have been performed in the water-bearing zones of the Rustler and Bell Canyon Formations. Transmissivities in these zones vary within nine orders of magnitude, and total dissolved solids range from a few thousand to 400,000 mg/L throughout the study area. The hydraulic data, for the most part, represent confined water-bearing horizons that range from stratigraphic contacts to 30 ft in thickness. Due to the low productivity, these zones would not be classified as aquifers anywhere else in the world. Wells within a 2-mi radius of the site and in the general SE direction of flow of the dominant aquifer in the Rustler (the Culebra Dolomite) yield no more than 0.2 gal/min over an extended period of pumping.

30598 **(SAND—83-0461) Dissolution of evaporites in and around the Delaware Basin, southeastern New Mexico and west Texas.** Lambert, S.J. (Sandia National Labs., Albuquerque, NM (USA)). Mar 1983. Contract AC04-76DP00789. 92p. NTIS, PC A05/MF A01. Order Number DE83011029.

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permian evaporites in the Ochoan Castile, Salado, and Rustler Formations in the Delaware Basin of southeast New Mexico and west Texas have been subjected to various degrees of dissolution (notably of halite and gypsum) through geologic time. Eastward tilting of the Delaware Basin has resulted in the exhumation and erosion of Ochoan rocks in the western part of the basin. Waters in the Capitan, Rustler, Castile, and Bell Canyon Formations have previously been proposed as agents or consequences of evaporite dissolution according to four principal models: solution-and-fill, phreatic dissolution, brine density flow, and stratabound dissolutin (along bedding planes). Several geomorphological features of positive and negative relief have previously been cited as indicators of evaporite dissolution. Brine density flow has been used to explain the selective dissolution of certain evaporite horizons during the late Cenozoic. A review of available geological data has revealed that: Halite deposition was probably not so extensive as formerly believed. Waters with potential to dissolve evaporites are in the Rustler and Capitan, but not in the Bell Canyon, Salado mine seeps, or the Castile brine reservoirs. Brine density flow has not been active in removing most of the missing halite, nor are point-source dissolution features likely to have their roots at the Bell Canyon. Major evaporite dissolution has not been confined to the late Cenozoic, but much of it took place during the Permian, Triassic, Jurassic, and Tertiary periods. The Bell Canyon Formation has been a sink for dissolution-derived brine.

30599 **(UCID—19769) Regional Seismic Test Network site descriptions.** Taylor, S.R.; Qualheim, B.J. (Lawrence Livermore National Lab., CA (USA)). 17 Mar 1983. Contract W-7405-ENG-48. 81p. NTIS, PC A05/MF A01. Order Number DE83010180.

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Each of the five Regional Seismic Test Network sites (RSTN) are characterized in terms of their geological and geophysical setting. The geology section includes a description of the regional geology and a detailed account of the geology in the immediate station vicinity. Stratigraphic columns and geophysical well-logs of the seismometer hole are also presented when available. The geophysics section for each site is divided into velocity structure and Q, regional seismicity and tectonics, and noise characteristics. Much of the information is derived from a literature review. However, when available, data have been analyzed from seismic stations at or near the sites and from preliminary analysis of actual RSTN data.

5802 Geophysics

REFER ALSO TO CITATION(S) 29002, 29062, 29096, 29099, 29163, 30599, 30814

30600 **(DOE/ER/10119—T4) Research in the geosciences related to resource assessment. Interim progress report.** Kivelson, M.G. (California Univ., Los Angeles (USA). Dept. of Earth and Space Sciences). 18 Jul 1980. Contract AT03-79ER10119. 15p. NTIS, PC A02/MF A01. Order Number DE83010244.

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Separate sections of the report deal with the development of a field data acquisition and processing system for use in exploration geophysics, analysis of seismic data from the Imperial Valley, California, and from Mt. Etna, and the genesis and geochemistry of uranium ore deposits in bogs in the Serra Nevada. (ACR)

30601 **(IFP—30-112) Interpolation and transformation of maps.** Mari, J.L. (Institut Francais du Petrole (IFP), 92 - Rueil-Malmaison; Paris-6 Univ., 75 (France)). Jun 1982. 182p. (In French). NTIS (US Sales Only), PC A09/MF A01. Order Number DE83750442.

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The purpose of this study is to present some mathematical and data processing for the simple, rapid processing and transformation of gravimetric and magnetic maps. The function of processing is to facilitate interpretation. It is supposed to make it possible to 'identify the geological objectives sought, without giving rise to fictitious events'. Hence the frequency content of the data must be retained and the generation of spurious frequencies must be avoided as much as possible. Two processing phases may be distinguished: - the first consists of homogenizing the values obtained in different recording conditions, - the second is more directly intended to help interpretation: in this second phase, an attempt is made to improve the quality of the documents by applying a set of carefully selected filters. Among these very special filters, the most widely used transformations are of three types: - prolongations, - derivations or vertical integrations, - reduction to the pole, for magnetism only. Initially, the quantitative aspect of these different transformations is examined

30602 **(USGS-OFR—82-1041) Principal facts of gravity stations with gravity and magnetic profiles from the southwest Nevada Test Site, Nye County, Nevada, as of January 1982.** Jansma, P.E.; Snyder, D.B.; Ponce, D.A. (Geological Survey, Menlo Park, CA (USA)). 1983. Contract AI08-78ET44802. 69p. NTIS, PC A04/MF A01. Order Number DE83010300.

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Three gravity profiles and principal facts of 2604 gravity stations in the southwest quadrant of the Nevada Test Site are documented in this data report. The residual gravity profiles show the gravity measurements and the smoothed curves derived from these points that were used in geophysical interpretations. The principal facts include station label, latitude, longitude, elevation, observed gravity value, and terrain correction for each station as well as the derived complete Bouguer and isostatic anomalies, reduced at 2.67 g/cm^3. Accuracy codes, where available, further document the data.

5803 Mineralogy, Petrology, And Rock Mechanics

REFER ALSO TO CITATION(S) 29098, 29122, 29232, 29517, 30592, 30598

30603 **(RHO-BW-SA—205A-P) Thermomechanical simulation of a nuclear-waste canister in a repository in basalt.** Topcubasi, A.F.; Lehnhoff, T.L.; Thirumalai, K. (Rockwell International Corp., Richland, WA (USA). Rockwell Hanford Operations). Aug 1982. Contract AC06-77RL01030. 6p. NTIS, PC A02/MF A01. Order Number DE83010608.

This paper discusses how a linear axisymmetric numerical thermo-elastic analysis, using average material properties, was determined to provide adequate accuracy for most near-yield predictions of temperatures, displacements, and stresses.

30604 **Method and apparatus for determining tensile strength.** Ratigan, J.L. US Patent Application 6-382,997. 28 May 1982. 14p. Contract W-7405-ENG-48.

A method and apparatus is described for determining the statistical distribution of apparent tensile strength of rock, the size effect with respect to tensile strength, as well as apparent deformation modulus of both intact and fractured or jointed rock. The method is carried out by inserting a plug of deformable material, such as rubber, in an opening of a specimen to be tested. The deformable material is loaded by an upper and lower platen until the specimen ruptures, whereafter the tensile strength is calculated based on the parameters of the test specimen and apparatus.

30605 **Finite-element method for coupled stress and fluid flow analysis in fractured rock masses.** Noorishad, J.; Ayatollahi, M.S.; Witherspoon, P.A. (Lawrence Berkeley Lab., CA). *International Journal of Rock Mechanics and Mining Sciences and Geomechanics Abstracts;* **19**: 185-193(1982).

A variational principle is used in conjunction with the finite-element method to solve the nonlinear coupled field equations of the initial boundary value problem of flow in deformable fractured rock masses. This results in a powerful method for modeling of coupled stress and fluid flow behavior of rocks. Both stress and deformation history for both solid and liquid phases, for arbitrary boundary conditions and within complex geometrical configuration, can be determined. Direct application is to fluid flow problems in hydraulically fractured reservoirs and naturally fractured rocks.

5804 Geochemistry

REFER ALSO TO CITATION(S) 29096, 29133, 29228, 29248

5805 Oceanography

REFER ALSO TO CITATION(S) 29241

64 PHYSICS RESEARCH

6401 Astrophysics And Cosmology

30606 **(DOE/ER/10774—3) Very high energy gamma ray astrophysics.** Lamb, R.C. (Iowa State Univ. of Science and Technology, Ames (USA)). Mar 1983. Contract AC02-80ER10774. 8p. NTIS, PC A02/MF A01. Order Number DE83009438.

We report our progress to detect sources of very high energy gamma rays ($E\gamma > 10^{11}$ eV) and to improve the instrumentation of detectors in this energy regime. Approximately 4 x 10^5 Cerenkov air shower events from the region of Cygnus X-3 and the Crab nebula have been collected with our JPL instrumentation during the fall of 1982. Analysis of these events is in progress. We should be able to improve significantly on our 1981 sensitivity to source variations. We also continue our collaboration at Mt. Hopkins to develop a Cerenkov air shower camera. A suitable mirror and mount for use as a detector auxiliary to the primary 10 inch Mt. Hopkins detector has been located. By May 1983 the mirror and mount should be moved to Mt. Hopkins and fitted for observations by the fall.

30607 **(FERMILAB-CONF—83/22) Underground neutrino astronomy.** Schramm, D.N. (Fermi National Accelerator Lab., Batavia, IL (USA); Chicago Univ., IL (USA). Astronomy and Astrophysics Center). Feb 1983. Contract AC02-80ER10773;AC02-76CH03000. 7p. (CONF-820989—6). NTIS, PC A02/MF A01. Order Number DE83008914.

From Workshop on science underground; Los Alamos, NM, USA (27 Sep 1982).

A review is made of possible astronomical neutrino sources detectable with underground facilities. Comments are made about solar neutrinos and gravitational-collapse neutrinos, and particular emphasis is placed on ultra-high-energy astronomical neutrino sources. An appendix mentions the exotic possibility of monopolonium.

30608 **(ITEF—23(1982)) Gasodynamical models of the type 2 supernovae.** Litvinova, I.Yu.; Nadezhin, D.K. (Gosudarstvennyj Komitet po Ispol'zovaniyu Atomnoj Ehnergii SSSR, Moscow. Inst. Teoreticheskoj i Ehksperimental'noj Fiziki). 1982. 54p. (In Russian). NTIS (US Sales Only), PC A04/MF A01. Order Number DE83700223.

A series of gasodynamical models of the type 2 supernova outbursts (SN 2) has been calculated. Approximate relations connecting the total outburst energy E, the mass of envelope ejected M, the presupernova radius R, and the amount of ionizing quanta radiated by the supernovae Nsub(H) with such values as the duration of the light curve plateau, and absolute magnitude in the wavelength band and photospheric velocity observed near the middle of the plateau have established. An advantage has been taken of the relations to obtain a preliminary evaluation of the characteristics of the average SN 2: $E=7x10^{50}$ erg, M=6 Msub(Sun), R=500 Rsub(Sun), Nsub(H)=$2x10^{56}$. The SN 2 with the plateau-like light curves seem to be accounted for by thermonuclear explosions of degenerate cores of the red giant stars and result in total disruption of the star without any stellar remnant. On the contrary, the SN 2 with the linear light curves have substantially different properties (in particular, they throw considerably less massive envelopes off). These SN 2 must signify the birth of collapsed objects-neutron stars (pulsars) or black holes.

30609 **(ITF—81-84-R) Kinetics of molecular hydrogen production, thermochemical evolution of protogalaxies primeval matter and properties of the first generation collapsing protostars.** Izotov, Yu.I.; Kolesnik, I.G. (AN Ukrainskoj SSR, Kiev. Inst. Teoreticheskoj Fiziki). 1981. 37p. (In Russian). NTIS (US Sales Only), PC A03/MF A01. Order Number DE83700224.

The molecular hydrogen formation in primeval gas of protogalaxies having T approximately 10^4 K and density n approximately 0.1-1 cm^{-3} is considered. Due to nonequilibrium conditions, the relative number density of H_2 molecules up to approximately 10^{-3} can be obtained. Cooling by molecular hydrogen leads to formation of cold fragments with masses approximately 10^3-10^4 Msub(Sun) and T approximately 10^2 K, involved in hot environment. Dynamical evolution of these fragments is considered and the conclusion is made that the first generation stars may be massive with Msub(*) approximately 70 Msub(Sun).

30610 **(JINR-R—2-81-645) Study of the Earth structure by neutrino experiments.** Nedyalkov, I.P. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Problems). 1981. 12p. (In Russian). NTIS (US Sales Only), PC A02/MF A01. Order Number DE83700225.

The problem on the study of the Earth structure by means of neutrino experiments is considered. It is shown that measuring of the attenuation of neutrino beams after their passage of the Earth one can reconstruct its density distribution. The reconstruction is performed with the aid of the formulae of computerized tomography. This procedure is successful if the intensity of neutrino beams is measur d with very high accuracy. The requirement is achieved by a new method of tugged neutrinos. The last is characterized by a very accurate measurement of the components π- and K-meson four-momentum and the four-momentum of the simultaneously generated muon. The conclusion is that if there would be

accelerators of few TeV energies and detectors of the DUMAND type, the experiment described is realisable.

30611 **(KFKI—1982-20) Observation of solar radio bursts of type II and III at kilometer wavelengths from Prognoz-8 during STIP Interval XII. 10 April - 21 June 1981.** Pinter, S.; Grigorieva, V.P.; Kecskemety, K.; Kudela, K. (Hungarian Academy of Sciences, Budapest. Central Research Inst. for Physics). Apr 1982. 13p. NTIS (US Sales Only), PC A02/MF A01. Order Number DE83700226.

Type II and type III radio events were observed at low frequencies (2.16 MHz to 114 kHz) by the Prognoz-8 satellite during the period of STIP Interval XII in April and May, 1981, respectively. This review covers briefly a chronology of the sub-megahertz radio events, and where possible their association with both groundbased radio observations and solar flare.

30612 **(LA-UR—83-643) Accretion disks.** Sparks, W.M.; Kutter, G.S. (Los Alamos National Lab., NM (USA); Evergreen State Coll., Olympia, WA (USA)). 1983. Contract W-7405-ENG-36. 5p. (CONF-830135—2). NTIS, PC A02/MF A01. Order Number DE83010161.

From 7. North American workshop on cataclysmic variables and low-mass X-ray binaries; Boston, MA, USA (12 Jan 1983).

Derivations are made for the mass and the mass-turnover time scale of an accretion disk as a function of the accretion rate, the observed disk radius, the non-viscous disk radius, and two parameters. These parameters depend on the effectiveness of viscosity and tidal angular momentum loss. Application is made to DQ Herculis.

30613 **(LA-UR—83-751) Cosmological and astrophysical implications of magnetic monopoles.** Kolb, E.W. (Los Alamos National Lab., NM (USA)). 11 Mar 1983. Contract W-7405-ENG-36. 21p. (CONF-830134—1). NTIS, PC A02/MF A01. Order Number DE83009969.

From Orbis scientiae conference; Miami, FL, USA (17 Jan 1983).

Among Dirac's many contributions to modern physics is the idea that charge quantization is natural in a theory with magnetic monopoles. The existence of magnetic monopoles would have drastic effects on the evolution of the universe, on galactic magnetic fields, and perhaps on the x-ray luminosity of neutron stars. Some astrophysical implications of massive magnetic monopoles are reviewed here.

30614 **(LA-UR—83-786) Delta Scuti variables. Lecture 6.** Cox, A.N. (Los Alamos National Lab., NM (USA)). 1983. Contract W-7405-ENG-36. 20p. (CONF-830337—7). NTIS, PC A02/MF A01. Order Number DE83010094.

From Swiss Society of Astrophysics and Astronomy conference; Saas Fee, Switzerland (21 Mar 1983).

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The class of variables near or on the upper main sequence, the delta Scuti variables, are not only the usual ones about the masses, radii, and luminosities, but also the age, rotation, element diffusion to change the surface layer composition, the occurance of convection and the presence of radial and nonradial pulsation modes. (GHT)

30615 **(LA-UR—83-787) Linear nonradial pulsation theory. Lecture 7.** Cox, A.N. (Los Alamos National Lab., NM (USA)). 14 Mar 1983. Contract W-7405-ENG-36. 18p. (CONF-830337—6). NTIS, PC A02/MF A01. Order Number DE83010090.

From Swiss Society of Astrophysics and Astronomy conference; Saas Fee, Switzerland (21 Mar 1983).

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Many of the upper main-sequence stars pulsate in spheroidal nonradial modes. We know this to be true in numerous cases, as we have tabulated for the β Cephei and δ Scuti variables in previous lectures. However, we cannot identify the actual mode for any star except for the low-order pressure p and f modes of our sun. It remains a great challenge to clearly state what really is occurring, in the process we learn more about how stars evolve and pulsate.

30616 **(LA-UR—83-789) Nonlinear hydrodynamics. Lecture 9.** Cox, A.N. (Los Alamos National Lab., NM (USA)). 14 Mar 1983. Contract W-7405-ENG-36. 18p. (CONF-830337—9). NTIS, PC A02/MF A01. Order Number DE83010082.

From Swiss Society of Astrophysics and Astronomy conference; Saas Fee, Switzerland (21 Mar 1983).

A very sophisticated method for calculating the stability and pulsations of stars which make contact with actual observations of the stellar behavior, hydrodynamic calculations are very simple in principle. Conservation of mass can be accounted for by having mass shells that are fixed with their mass for all time. Motions of these shells can be calculated by taking the difference between the external force of gravity and that from the local pressure gradient. The conservation of energy can be coupled to this momentum conservation equation to give the current temperatures, densities, pressures, and opacities at the shell centers, as well as the positions, velocities, and accelerations of the mass shell interfaces. Energy flow across these interfaces can be calculated from the current conditions, and this energy is partitioned between internal energy and the work done on or by the mass shell. We discuss here only the purely radial case for hydrodynamics because it is very useful for stellar pulsation studies.

30617 **(LA-UR—83-790) Supergiant radial and nonradial pulsations. Lecture 10.** Cox, A.N. (Los Alamos National Lab., NM (USA)). 14 Mar 1983. Contract W-7405-ENG-36. 20p. (CONF-830337—8). NTIS MF A01. Order Number DE83010083.

From Swiss Society of Astrophysics and Astronomy conference; Saas Fee, Switzerland (21 Mar 1983).

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The stars that we consider here have luminosities above 10,000 solar luminosities and masses above 15 solar masses. We contact the 53 Per stars such as ν Ori, 10 Lac, and iota CMa at our lower luminosity limit, and at the most luminous limit, we have the famous stars eta Car, Cyg OB12, and P Cyg. Evolution tracks including a reasonable mass loss rate are given for 15, 30, 60, and 120 solar masses. It appears that our pulsators have masses less than 60 solar masses, but how do the most luminous stars observed survive mass loss. Do they have masses above 100 solar masses as indicated, or are these stars somehow superluminous due to their erratic mass loss behavior. Popper (1980) studying the masses in binary systems has never found one with a value greater than 27 solar masses.

30618 **(LA-UR—83-812) Positrons from supernova and the origin of the galactic-center positron-annihilation radiation.** Colgate, S.A. (Los Alamos National Lab., NM (USA)). 17 Mar 1983. Contract W-7405-ENG-36. 9p. (CONF-830136—1). NTIS, PC A02/MF A01. Order Number DE83009997.

From Workshop on positron-electron pairs in astrophysics; Greenbelt, MD, USA (6 Jan 1983).

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The emission of positrons from supernova ejecta is dicussed in terms of the galactic-center annihilation radiation. The positrons from the radioactive sequences $^{56}Ni \rightarrow ^{56}Co \rightarrow ^{56}Fe$ are the most numerous source from supernova. Only type I supernova will allow a significant fraction to escape the expanding ejecta. For a neutron star model of a type I SN a fraction 4×10^{-3} of the escaped positron is enough to create the observed several year fluctuation of the annihilation radiation. The likelihood of this model is discussed in terms of other astrophysical evidence as well as the type I SN light curve.

30619 **(LA-UR—83-892) Cataclysmic variables as probes of x-ray properties of interstellar grains.** Bode, M.F.; Evans, A.; Norwell, G.A. (Los Alamos National Lab., NM (USA); Keele Univ. (UK)). 1983. Contract W-7405-ENG-36. 7p. (CONF-830135—1). NTIS, PC A02/MF A01. Order Number DE83009888.

From 7. North American workshop on cataclysmic variables and low-mass X-ray binaries; Boston, MA, USA (12 Jan 1983).

Interstellar-grain properties have previously been probed at wavelengths ranging from the infrared to the ultraviolet. Recent

work by other authors has shown that we may also observe the effects of scattering by such grains at x-ray wavelengths. In this paper we suggest that investigations of the x-ray properties of interstellar grains may profitably be conducted in sight lines to variable sources. Particular emphasis is given in this context to cataclysmic variables and related objects.

30620 **(LA-UR—83-977) Spacecraft charging and related effects during Halley encounter.** Young, D.T. (Los Alamos National Lab., NM (USA); Southwest Research Inst., San Antonio, TX (USA)). 1983. Contract W-7405-ENG-36. 18p. (CONF-821183—1). NTIS, PC A02/MF A01. Order Number DE83009912.

From International conference on cometary exploration; Budapest, Hungary (15 Nov 1982).

Hypervelocity (69 km/s) impact of cometary material with surfaces of the GIOTTO spacecraft will induce a number of spurious and possibly harmful phenomena. The most serious of these is likely to be spacecraft charging that results from impact-produced plasma distributions surrounding GIOTTO. The ESA Plasma Environment Working Group, whose studies are the basis for this report, finds that charging may become significant within $\sim 10^5$ km of the nucleus where potentials of $\approx +20$ V are to be expected. In addition to spacecraft charging, impact produced plasma may interfere with in situ plasma measurements, particularly those of ion plasma analyzers and mass spectrometers.

30621 **(VT—1) Nonlinear mechanism of radiation generation in pulsar plasma.** Mikhajlovskij, A.B.; Suramlishvili, G.I. (AN Gruzinskoj SSR, Tbilisi. Inst. Fiziki). 1981. 6p. (In Russian). NTIS (US Sales Only), PC A02/MF A01. Order Number DE83700227.

With account for electron - positron structure of the pulsar magnetosphere plasma nonlinear mechanisms of its radiation generation are considered. A high level of Langmuir oscillations in a pulsar plasma is supposed. Estimates of radiation energy increase velocity are presented under the condition that the cyclotron frequency does not exceed the plasma one. An assumption is made that such condition can be realized near the light cylinder. The mechanisms considered lead to radio and infrared radiation of young pulsars and to radio radiation of old pulsars.

30622 **Equation of state experiments and theory relevant to planetary modelling.** Ross, M.; Graboske, H.C. Jr.; Nellis, W.J. (Lawrence Livermore National Lab., CA). *Philosophical Transactions of the Royal Society of London, Series A: Mathematical and Physical Sciences;* **303**: 303-313(1981). Contract W-7405-ENG-48.

In recent years there have been a number of static and shockwave experiments on the properties of planetary materials. The highest pressure measurements, and the ones most relevant to planetary modelling, have been obtained by shock compression. Of particular interest to the Jovian group are results for H_2, H_2O, CH_4 and NH_3. Although the properties of metallic hydrogen have not been measured, they have been the subject of extensive calculations. In addition recent shock wave experiments on iron report to have detected melting under earth core conditions. From this data theoretical models have been developed for computing the equations of state of materials used in planetary studies. A compelling feature that has followed from the use of improved material properties is a simplification in the planetary models. 51 references, 5 figures.

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REFER ALSO TO CITATION(S) 29965, 30819

30623 **(AERE-TP—890) Doppler-free two-photon excitation of ^{238}U.** Hodgkinson, D.P.; Wort, D.J.H. (UKAEA Atomic Energy Research Establishment, Harwell. Theoretical Physics Div.). Apr 1981. 40p. NTIS (US Sales Only), PC A03/MF A01. Order Number DE83700198.

A theory of resonantly enhanced two-photon absorption is presented and tested in a number of experiments in which ^{238}U vapour is excited by two continuous wave dye lasers. Good quantitative agreement between theory and experiment is found. In particular the central prediction of the theory, that antiparallel laser beams of modest intensity can pump an appreciable fraction of the Maxwell velocity distribution, has been checked directly by measuring the spectral width of the fluorescence from the two-photon excited level.

30624 **(ANL—81-85-Pt.1) Radiological and Environmental Research Division annual report: fundamental molecular physics and chemistry, October 1980-September 1981.** (Argonne National Lab., IL (USA)). Dec 1982. Contract W-31-109-ENG-38. 155p. NTIS, PC A08/MF A01. Order Number DE83009476.

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Research summaries are presented for fundamental molecular physics and chemistry. Of the forty-three items in the report, thirty-six were included previously in the data base. Abstracts of seven items were prepared separately for inclusion in this issue and in the data base. (GHT)

30625 (ANL—81-85-Pt.1, pp 90-92) **Angular distribution of electrons inelastically scattered from HgBra2 between 4 and 14 eV.** Spence, D.; Wang, R.G.; Dillon, M.A. Dec 1982. NTIS, PC A08/MF A01.

In Radiological and Environmental Research Division annual report: fundamental molecular physics and chemistry, October 1980-September 1981.

Spectra of electrons inelastically scattered from $HgBr_2$ and $HgCl_2$ were presented for incident electron energies of 200 eV, scattering angle 3°, and energy loss between 4 and 14 eV. Under the experimental conditions the energy loss spectrum corresponds closely to the optical absorption intensity distribution. In addition to well-known optical absorption bands, those spectra revealed many new energy-loss processes, mainly due to Rydberg state excitation, at energies above about 7 eV. In order to provide more guidance to interpretation of these spectra, we have recently extended our measurements to larger scattering angles, where one may reasonably expect a separation of features resulting from allowed and forbidden states to occur. In this present short report we present no further analysis but merely show a small portion of our extensive data for $HgBr_2$ and which we will later use in further analysis of our spectra.

30626 (ANL—81-85-Pt.1, pp 93-94) **Electron energy loss spectra in hydrogen chloride.** Wang, R.G.; Dillon, M.A.; Spence, D. Dec 1982. NTIS, PC A08/MF A01.

In Radiological and Environmental Research Division annual report: fundamental molecular physics and chemistry, October 1980-September 1981.

We have obtained the first electron energy loss spectra in hydrogen chloride in the energy loss range of 5 to 19 eV for incident electron energies of 200 eV and scattering angles between 0° and 25°.

30627 (ANL—81-85-Pt.1, pp 95-97) **Electron energy loss spectroscopy in molecular chlorine.** Spence, D.; Wang, R.G.; Dillon, M.A. Dec 1982. NTIS, PC A08/MF A01.

In Radiological and Environmental Research Division annual report: fundamental molecular physics and chemistry, October 1980-September 1981.

We have obtained electron energy loss spectra in molecular chlorine in the energy-loss range of 5 to 14 eV for incident electron energy of 200 eV and scattering angles between 3° and 15°. Under the experimental conditions the spectra obtained for scattering angles near the forward direction correspond closely to optical absorption spectra, the most prominent features arising from excitation of optically allowed Rydberg states.

30628 (ANL—81-85-Pt.1, pp 99-103) **Phenomenological study of heterogeneous chemical reactions on heated stainless steel surfaces relevant to mercuric halide lasers.** Wang, R.G.; Dillon, M.A.; Spence, D. Dec 1982. NTIS, PC A08/MF A01.

In Radiological and Environmental Research Division annual report: fundamental molecular physics and chemistry, October 1980-September 1981.

Although the mercuric halides have received intensive study in recent years, because of their potential use as electronic transition laser systems, very little is known, even on a qualitative basis, of the chemical reactions that occur in practical laser devices containing mercuric halides. Mercuric halides are solid crystalline compounds at room temperature, and sufficient vapor pressure for efficient laser operation is usually achieved by heating the salt to between 100° and 200°C, in a discharge cavity usually constructed of stainless steel. In an attempt to shed light on some possible chemical species which may be produced in laser cavities, and the concomitant reactions which may occur on heated stainless steel surfaces, we have used the technique of electron energy loss spectroscopy as an analytic tool.

30629 (ANL—81-85-Pt.1, pp 119-124) **Least squares fitting method for transitions with resonances.** Dillon, M.A. Dec 1982. NTIS, PC A08/MF A01.

In Radiological and Environmental Research Division annual report: fundamental molecular physics and chemistry, October 1980-September 1981.

Energy-level transitions can be simulated by least squares polynomial fits to relative oscillator strength distribution. An example used is the argon 3p to s,d transition. (GHT)

30630 (ANL—81-85-Pt.1, pp 125-127) **Phase shifts in the GWKB approximation.** Dillon, M.A. Dec 1982. NTIS, PC A08/MF A01.

In Radiological and Environmental Research Division annual report: fundamental molecular physics and chemistry, October 1980-September 1981.

The most flexible semiclassical treatment of the radial Schroedinger equation is the generalized WKB approximation. The atomic phase shifts calculated by direct integration of the radial equation are compared with those obtained by application of the GWKB approximation. (GHT)

30631 (BNL—32706) **Classical estimates of the numbers of normal, local and stochastic states of polyatomic molecules as functions of energy: applications to H_2O.** Ruf, B.A.; Muckerman, J.T.; Ashton, C.J.; Noid, D.W. (Brookhaven National Lab., Upton, NY (USA); Oak Ridge National Lab., TN (USA)). 1983. Contract AC02-76CH00016. 4p. (CONF-830433—1). NTIS, PC A02/MF A01. Order Number DE83009727.

From SRC conference on intramolecular kinetics; Warwick, UK (18 Apr 1983).

For a general polyatomic molecule, the classical phase space at some fixed energy and angular momentum is divisible into two regimes: a quasiperiodic and a stochastic (or chaotic) regime. In certain molecules - those having symmetrically equivalent X-H bonds, where X is any heavy atom - the classical trajectories comprising the quasiperiodic regime can be subdivided into two classes: normal trajectories, for which the time-averaged amplitudes in all the X-H stretching vibrations are equivalent, and local trajectories, which exhibit a permanent imbalance in the amplitudes of the various X-H stretching vibrations. We report here the development of trajector diagnostics for bound, nonseparable motion to distinguish normal, local, and stochastic types of motion in systems with more than two internal (coordinate) degrees of freedom, and the application of these diagnostics to determine the numbers of normal, local, and stochastic states of a realistic model of nonrotating H_2O as functions of energy. This application is the first such study for a real polyatomic molecule.

30632 (CONF-810231—5) **Coulomb-explosion technique for determining geometrical structures of molecular ions.** Gemmell, D.S. (Argonne National Lab., IL (USA)). 1981. Contract W-31-109-ENG-38. 25p. NTIS, PC A02/MF A01. Order Number DE83010587.

From 5. international conference on ion beam analysis; Sydney, Australia (16 Feb 1981).

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Traditional experimental techniques (e.g. studies on photon absorption or emission) for determining the sterochemical structures of neutral molecules are extremeley difficult to apply to molecular ions because of problems in obtaining a sufficient spatial density of the ions to be studied. Recent high-resolution measurements on the energy and angle distributions of the fragments produced when fast (MeV) molecular-ion beams from an electrostatic accelerator dissociate (Coulomb explode) in thin foils and in gases, offer promising possibilities for deducing the sterochemical structures of the molecular ions constituting the incident beams. Bond lengths have been determined in this way for several diatomic projectiles (H_2^+, HeH^+, CH^+, NH^+, OH^+, N_2^+, O_2^+, etc.) with an accuracy of $\sim$ 0.01 A. H_3^+ has been demonstrated (for the first time) to be equilateral triangular and the interproton distance measured. Measurements on single fragments from CO_2^+, N_2O^+, $C_2H_2^+$, and CH/sub n/$^+$ have revealed the gross structures of the projectiles. An apparatus has recently been constructed at Argonne to permit precise measurements on fragments in coincidence. The apparatus has been tested on a known structure (OH_2^+). The O-H bond length was found to be 1.0 +- 0.04 A and the H-O-H bond angle was measured as 110 — 2°. These values are in excellent agreement with those found in optical experiments (0.999 A and 110.5°). This Coulomb explosion technique can be expected to be refined in accuracy and to be extended to a wide range of molecular ions whose structures are inaccessible by other means.

30633 (CONF-821066—4) **Ion-source development at Argonne.** Billquist, P.J.; Yntema, J.L. (Argonne National Lab., IL (USA)). 1982. Contract W-31-109-ENG-38. 7p. NTIS, PC A02/MF A01. Order Number DE83008911.

From Symposium for Northeastern Accelerator personnel; Seattle, WA, USA (6 Oct 1982).

Brief descriptions are given of the ion source test stand, the ANIS source, a copy of the SNICS source, and the Chapman inverted sputter source. Relative performance is discussed, particularly for the inverted sputter source. Beam currents are given for several ion species. (GHT)

30634 (CONF-830449—1) **Interactions of fast molecular-ion beams with matter.** Gemmell, D.S.; Kanter, E.P.; Schneider, D. (Argonne National Lab., IL (USA)). 1983. Contract W-31-109-ENG-38. 4p. NTIS, PC A02/MF A01. Order Number DE83010798.

From DOE contractors workshop; Oak Ridge, TN, USA (21 Apr 1983).

Topics covered include: contribution of field-ionized Rydberg atoms to convoy electron spectra; microwave field ionization of fast Rydberg atoms; coherent Stark states in foil-excited fast Rydberg atoms; and equilibration lengths of K-Vacancy production in solids. (GHT)

30635 (CONF-8208130—1) **Studies of photoionization processes from ground-state and excited-state atoms and molecules.** Ederer, D.L.; Parr, A.C.; West, J.B. (National Bureau of Standards, Washington, DC (USA). Radiation Physics Div.; Science Research Council, Daresbury (UK). Daresbury Lab.; Reading Univ. (UK); Maryland Univ., College Park (USA); Argonne National Lab., IL (USA); Paris-11 Univ., 91 - Orsay (France). Centre de Spectrometrie Nucleaire et de Spectrometrie de Masse; Centre National de la Recherche Scientifique, 91 - Orsay (France). Lab. Aime Cotton; Yale Univ., New Haven, CT (USA)). 1982. Contract W-31-109-ENG-38. 14p. NTIS, PC A02/MF A01. Order Number DE83010595.

From Workshop on techniques for the production and utilization of polarization radiation in the vacuum ultraviolet; London, UK (18 Aug 1982).

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Recent triply-differential photoelectron spectroscopy experiments designed for the study of correlation effects in atoms and molecules are described. Final-state symmetry of the n=2 state of helium has been determined. The non-Franck-Condon behavior of vibrational branching ratios and large variations of the angular asymmetry parameter has been observed for shape resonances and autoionizing resonances in CO and other molecules. Recent observations of the photoionization of excited sodium atoms are also described.

30636 (DOE/ER/10748—3) Many-body processes in atomic and molecular physics. Progress report, September 1, 1982-August 31, 1983. Chu, S.I. (Kansas Univ., Lawrence (USA). Dept. of Chemistry). Apr 1983. Contract AC02-80ER10748. 30p. NTIS, PC A03/MF A01. Order Number DE83010372.

Progress is reported in the following areas: (1) development of a powerful semiclassical many-mode Floquet theory for nonperturbative treatment of the multiphoton dynamics of a quantum system interacting with several monochromatic radiation fields, (2) development of analytical quasi-level models for line shape analysis of intense field molecular multiphoton absorption spectra, (3) completion of a high-precision rotatonal predissociation lifetime determination of Ar-H_2 and Ar-HD van der Waals (vdW) molecules, using the complex-coordinate coupled-channel (CCCC) formalisms, and (4) development of the complex quasi-vibrational energy (QVE) and the inhomogeneous differential equation (IDE) approaches for calculating multiphoton dissociation (MPD) rates from highly excited vibrational states of diatomic molecules. (WHK)

30637 (DOE/ER/12081—1) Hyperspherical coordinate theory of two electron atomic processes. Progress report, 1 August 1982-31 July 1983. Macek, J.; Starace, A.F. (Nebraska Univ., Lincoln (USA)). Mar 1983. Contract AC02-82ER12081. 11p. NTIS, PC A02/MF A01. Order Number DE83010917.

A multidimensional R-matrix type approximation is formulated for the situation where two electrons emerge from a region near an atomic nucleus. Essentially exact wave functions based on the Fock expansion are used inside a hyperradius R_0, and superpositions of adiabatic channel functions are used outside of R_0. The appropriate superposition of Fock solutions in the inner region and adiabatic channel functions in the outer region are determined by minimizing the difference between the two representations at R_0. We show that this procedure gives a set of eigenvalues equal in number to the number of channel functions used in the outer region. The eigenvalues and corresponding eigenvectors then determine the starting conditions for the outward integration of the adiabatic equations. A computer program to generate the Fock coefficients recursively has been written and is being debugged. A complete classification of the Wannier modes of motion for three interacting particles has been formulated ad used to analyze threshold angular distributions of secondary electrons. Wave functions based on the 0_4 classification have been compared with adiabatic functions and elaborate configuration interaction functions. We find that one 0_4 mode, namely that mode which minimizes the electron-electron repulsion, is accurately represented in the 0_4 classification scheme. All others are inaccurate to varying degrees.

30638 (DOE/NBM—3010753) Formation of Rydberg states in fast ion-atom collisions. Schneider, D.; Kanter, E.P.; Vager, Z.; Gemmell, D.; Koch, P.; Mariani, D.; Van de Water, W. (Argonne National Lab., IL (USA)). 1983. Contract W-31-109-ENG-38. 4p. NTIS, PC A02/MF A01. Order Number DE83010753.

Previous results from beam-foil spectroscopy and from experiments using field ionization techniques have shown that a significant fraction of fast ionic projectiles traversing solid targets can be excited to high Rydberg states. We report an experimental investigation of Rydberg states formed in atomic and molecular ion beams (MeV) emerging from thin-carbon foils. Different field arrangements, including μ-wave fields, have been applied to study the effects of field ionization. The yields of electrons produced via field ionization are compared for different projectile atoms and molecules.

30639 (GEPP-TIS—726a) Influence of gap length on the field increase factor β. Miller, H.C. (General Electric Co., St. Petersburg, FL (USA). Neutron Devices Dept.). 7 Apr 1983. Contract AC04-76DP00656. 19p. NTIS, PC A02/MF A01. Order Number DE83009599.

β, the increase of the macroscopic electric field at the tip of a projection, varies with the gap length. The sign and magnitude of this variation depends upon how the gap length is defined. If gap length is defined as x, the distance from the projection tip to the opposing electrode, than β is a strong function of x and may be approximated by $\beta(x) = \beta/\text{sub } \infty/\ x/(x + h)$ [h = projection height] in the region where $x/h > 10/\beta/\text{sub } \infty/$. If gap length is defined as d, the interelectrode distance ignoring the projection, the β is a weak function of d and may be set equal to $\beta/\text{sub } \infty/$ in the region $d/h > 2$.

30640 (IAE—3374/11) Model for investigating high-energy cascade by computer modelling. Kapinos, V.G.; Kevorkyan, Yu.R. (Gosudarstvennyj Komitet po Ispol'zovaniyu Atomnoj Ehnergii SSSR, Moscow. Inst. Atomnoj Ehnergii). 1981. 29p. (In Russian). NTIS (US Sales Only), PC A03/MF A01. Order Number DE83700202.

A new model for investigating high-energy cascades making it possible to estimate the influence of temperature and impurity disturbances on the defect distribution in cascade damage regions (CDR) is proposed. The cascade high energy part is described in the pair collision approximation, the low- energy part by means of a special algolithm which is based on the semiphenomenological description of the process of substituting collision chains (SCC) development. The temperature effect on the SCC development has been evaluated according to the Pugatcheva theory. The algorithm describing the SCC development process is approved on the proper problems calculated by the molecular dynamics method. The satisfactory correspondence of results for both: static and "hot" d-Fe and Cu lattices is shown. Calculations of SCC lengths in Cu and α-Fe at different temperatures, various directions and primary-knocked out atom (PNA) energies are carried out. It is shown that SCC average lengths are inessentially dependent on crystal temperature in the range from 0 to 500 K. The calculations of cascades initiated by PNA with energy of 15 keV at T=500 K in the α-Fe lattice containing implantation impurity are performed. It is shown that up to concentrations approximately 2000 ppm the impurity does not essentially effect on the dynamic phase of cascade development.

30641 (JINR—R-4-81-835) Charge screening effects in mesic molecules of hydrogen isotopes. Bakalov, D.D.; Melezhik, V.S. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1981. 12p. (In Russian). NTIS (US Sales Only), PC A02/MF A01. Order Number DE83700199.

The charge screening effects in the molecular complexes [(DD sub(μ))D2e] and [(DT sub(μ))D2e] have been evaluated with the use of the mesic molecule wave functions calculated in the adiabatic representation of the three-body problem with account of the hyperfine structure of the mesic molecule energy levels. It has been shown that in the weakly bound states of DD sub(μ) and DT sub(μ) screening effects shift the molecular-complex energy levels of [(DD sub(μ))D2e] and [(DT sub(μ))D2e] by 16 MeV and 25 MeV, respectively, that is equivalent to a shift of the resonance temperature of their formation of about 100 deg C, resp. 200 deg C. In the remaining states of the mesic molecules the energy levels shift does not exceed a few MeV. The quadrupole splitting of the molecular-complex energy levels has also been evaluated: in the weakly bound states it equals about 2 MeV.

30642 (JINR—R-4-81-851) Hyperfine energy level structure of the Dμ mesoatom and DDμ mesomolecule and kinetics of mesomolecular processes in deuterium. Somov, L.N. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Problems). 1981. 6p. (In Russian). NTIS (US Sales Only), PC A02/MF A01. Order Number DE83700200.

It is shown that taking account of a hyperfine structure (HFS) of energy levels in a muonic atom dsub(μ) and muonic molecule ddsub(μ) brings to the observation of new physical effects. Organization of experiments studying these effects is discussed. The calculation of the kinetics of mesomolecular processes with taking into account (HFS) is presented. Time and integral yields of fusion products taking into account (HFS) are obtained. It is demonstrated that in experiments studying the rate of muonic molecule ddsub(μ) production at low pressures and temperatures of 20-100 K one can define the location of a resonance with an absolute accuracy of the order of approximately 10^{-5} eV.

30643 (LA-UR—83-847) Multiphoton-induced fluorescence and ionization of B^1u^+ carbon monoxide. Loge, G.W.; Tiee, J.J.; Wampler, F.B. (Los Alamos National Lab., NM (USA)). 1983. Contract W-7405-ENG-36. 14p. (CONF-830425—5). NTIS, PC A02/MF A01. Order Number DE83010095.

From Society of Photo-Optical Instrumentation Engineers conference; Santa Fe, NM, USA (11 Apr 1983).

The $B^1\Sigma^+$ state of carbon monoxide was created by a two-photon absorption of 230-nm laser radiation. The $B^1\Sigma^+$ state was identified by the positions of the 0-0 absorption band Q-branch and the vibrational bands of $B^1\Sigma^+ \rightarrow A^1PI$ fluorescence occurring in the 525-nm region. Collision-induced $b^3\Sigma^+ \rightarrow a^3PI$ emission in the 350-nm region was also observed. The lifetimes of both the $B^1\Sigma^+$ state and the $b^3\Sigma^+$ state were measured as well as the self-quenching rate constants and the $B^1\Sigma^+$ quenching rate by N_2. In addition to the two-photon-induced fluorescence of $B^1\Sigma^+$ carbon monoxide, a three-photon ionization was observed. Laser power-dependence studies indicated that ionization of the $B^1\Sigma^+$ state is readily saturated, implying that most $B^1\Sigma^+$ state CO is ionized rather than fluoresecing. Measurement of the polarization ratio for circularly and linearly polarized excitation of fluorescence and ionization suggests that another three-photon process is occurring and occurs more efficiently for linear polarization.

30644 (LA-UR—83-872) Multiphoton laser-induced-fluorescence studies of simple species. Tiee, J.J.; Ferris, M.J.; Loge, G.W.; Wampler, F.B. (Los Alamos National Lab., NM (USA)). 1983. Contract W-7405-ENG-36. 18p. (CONF-830425—4). NTIS, PC A02/MF A01. Order Number DE83009884.

From Society of Photo-Optical Instrumentation Engineers conference; Santa Fe, NM, USA (11 Apr 1983).

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Recent studies have demonstrated multiple-photon excitation of atomic species. Bischel and coworkers have provided a detailed description of two-photon excitation fluorescence in the detection of atoms generated in a low pressure discharge and its possible application as a diagnostic tool in flame and plasmas. It is also believed that such techniques can be useful in detecting molecular transients which are difficult to detect otherwise as demonstrated in two-photon laser-induced fluorescence (LIF) detection of NO. In this paper, we discuss our recent two-photon LIF studies on I and Br atoms, which are produced via laser photolysis of molecular precursors. The two-photon LIF study of HS and DS radicals is presented as a test case for the detection of other important radical species such as C_2H and CH_3, which are currently being investigated in our laboratory. In addition, excitation of three-photon resonances of I_2, N_2, and H_2 is discussed.

30645 (ORNL/TM—8693) Search for existence of D_2p, D_3^-, and HD_2^- formed in double-electron-capture collisions. Barnett, C.F. (Oak Ridge National Lab., TN (USA)). Mar 1983. Contract W-7405-ENG-26. 15p. NTIS, PC A02/MF A01. Order Number DE83010410.

A search has been made for the existence of D_2^-, D_3^-, and HD_2^- ions formed by double electron capture collisions of the parent positive molecular ions in H_2 and Xe. Negative molecular ions were not observed indicating the double electron capture cross sections for formation of D_2^-, D_3^- and HD_2^- must be less than 10^{-20} cm^2 in the energy range 10 to 50 keV.

30646 High power linear pulsed beam annealer. Sadana, D.K.; Strathman, M.D.; True, R.B. (to Dept. of Energy). US Patent 4,371,774. 1 Feb 1983. Filed date 26 Nov 1980. vp.

PAT-APPL-210488.

A high power pulsed electron beam is produced in a system comprised of an electron gun having a heated cathode, control grid, focus ring, and a curved drift tube. The drift tube is maintained at a high positive voltage with respect to the cathode to accelerate electrons passing through the focus ring and to thereby eliminate space charge. A coil surrounding the curved drift tube provides a magnetic field which maintains the electron beam focused about the axis of the tube and imparts motion on electrons in a spiral path for shallow penetration of the electrons into a target. The curvature of the tube is selected so there is no line of sight between the cathode and a target holder positioned within a second drift tube spaced coaxially from the curved tube. The second tube and the target holder are maintained at a reference voltage that decelerates the electrons. A second coil surrounding the second drift tube maintains the electron beam focused about the axis of the second drift tube and compresses the electron beam to the area of the target. The target holder can be adjusted to position the target where the cross section of the beam matches the area of the target.

30647 Spectroscopy and lifetime measurements of highly ionized nickel. Jacques, C.; Knystautas, E.J. (Laval Univ., Quebec City (Canada). Dept. de Physique); Druetta, M. (Lyon-1 Univ., 69 - Villeurbanne (France). Lab. de Spectrometrie Ionique et Moleculaire); Berry, H.G. (Argonne National Lab., IL (USA)). *Nuclear Instruments and Methods in Physics Research;* **202**: No. 1/2, 45-47(1 Nov 1982). (In French).

From 6. international conference on fast ion beam spectroscopy; Quebec (Canada) (17 - 20 Aug 1981).

Spectra of highly ionized nickel have been taken using beams of Ni^+ at energies between 2 and 4 MeV in different spectral regions from 100 to 2000 A. We present the most probable identifications as well as the results of 21 lifetime measurements of excited levels.

30648 Search for promethium-like gold lines and other transitions of interest to fusion research. Johnson, B.M.; Jones, K.W. (Brookhaven National Lab., Upton, NY (USA)); Kruse, T.H. (Rutgers - the State Univ., Piscataway, NJ (USA)); Curtis, L.J.; Ellis, D.G. (Toledo Univ., OH (USA)). *Nuclear Instruments and Methods in Physics Research;* **202**: No. 1/2, 53-58(1 Nov 1982).

From 6. international conference on fast ion beam spectroscopy; Quebec (Canada) (17 - 20 Aug 1981).

EUV spectra in the range lambda = 13 - 40 nm were measured for foil-excited gold ions at 31-238 MeV. Data were recorded at the higher energies to extend and to complement previous measurements and at the lowest energy to see if the recently predicted 5s - 5p resonance lines in the Pm-like ion, Au XIX, could be seen in beam-foil excitation. The experimental results are presented, previous beam-foil measurements are reviewed, and the contributions and relations to fusion research are discussed.

30649 Doubly excited states in some light atoms. Berry, H.G.; Brooks, R.L.; Hardis, J.E.; Ray, W.J. (Argonne National Lab., IL (USA). Physics Div.). *Nuclear Instruments and Methods in Physics Research;* **202**: No. 1/2, 73-74(1 Nov 1982).

From 6. international conference on fast ion beam spectroscopy; Quebec (Canada) (17 - 20 Aug 1981).

We have identified a singlet transition in doubly excited helium: $2p^2\ ^1D$-$2p3d\ ^1D$, at 3298 +- 2 A with a full width of 54 A or 0.061 +- 0.005 eV. This width is in good agreement with a previous measurement and theory for the width of the $2p^2\ ^1D_2$ state. We have remeasured the decay rate of $1s^22p\ ^2P$-$1s2p^2\ ^2P$ in Li I and find it is in good agreement with theory. Several transitions in doubly excited Li II have been identified in the 1000 A region. No evidence was found for doubly excited quartet transitions in Li I in the vacuum ultraviolet. We present measurements of wavelengths and fine structure of the $1s2s2p^2\ ^5P$-$1s2p^3\ ^5S$ transitions in C III, N IV and O V.

30650 Comparisons between theory and experiment in two electron systems. Berry, H.G.; DeSerio, R.; Brooks, R.L. (Argonne National Lab., IL (USA). Physics Div.). *Nuclear Instruments and Methods in Physics Research;* **202**: No. 1/2, 95-101(1 Nov 1982).

From 6. international conference on fast ion beam spectroscopy; Quebec (Canada) (17 - 20 Aug 1981).

We shall report on several recent measurements of the wavelengths of the $1s2s\ ^3S_1$-$1s2p\ ^3$Psub(0,2) transitions in helium-like ions of nuclear charge Z = 8 - 26 at several laboratories, including Argonne, Notre Dame, Oxford, Lyon, Berkely and Lund. The precision of some of these measurements is sufficient to test the QED contributions to these transition energies to a few parts per thousand. Our theoretical understanding of such transitions will also be

summarized. We show that a first-order screening correction to the one-electron Lamb shift gives close agreement between theory and all experiments for the two-electron system. It also provides agreement at a similar level of precision with a recent experimental Lamb-shift measurement in one-electron chlorine. We present a calculation of the 1s2p ^{3}P(J = 1 - 2) fine-structure splitting in helium-like fluorine which is in much closer agreement with recent measurements than previous calculations.

30651 **Hyperfine structures of the nd^{1}D(n=3-8) states of ^{3}He I.** Brooks, R.L.; Streif, V.F.; Berry, H.G. (Argonne National Lab., IL (USA). Physics Div.). *Nuclear Instruments and Methods in Physics Research;* **202**: No. 1/2, 113-117(1 Nov 1982).

From 6. international conference on fast ion beam spectroscopy; Quebec (Canada) (17 - 20 Aug 1981).

We have used the beam-foil quantum beat method to measure the hyperfine structure separations F = 3/2 - 5/2 of the 1snd ^{1}D states (n = 3 - 8) of ^{3}He I. We observed the single frequency modulated decay curves of the 1s2p ^{1}P-1snd ^{1}D transitions for times after excitation up to 50 ns, correspondinq to 4 - 5 modulation periods. The frequency obtained (with a precision of 2 - 5%) are compared with other experiments and theory. The frequencies are determined mainly by the singlet-triplet energy separations and mixing factors for the He I D-states. The results agree with the same parameters obtained from other recent level-crossing measurements in strong magnetic field mixing of the singlet-triplet states.

30652 **Collinear fast-beam laser spectroscopy experiment: Measurement of hyperfine structure and isotope shifts in Xe II.** Bingham, C.R.; Gaillard, M.L.; Pegg, D.J. (Tennessee Univ., Knoxville (USA); Oak Ridge National Lab., TN (USA)); Carter, H.K.; Mlekodaj, R.L. (UNISOR, Oak Ridge, TN (USA)); Cole, J.D. (Louisiana State Univ., Baton Rouge (USA)); Griffin, P.M. (Oak Ridge National Lab., TN (USA)). *Nuclear Instruments and Methods in Physics Research;* **202**: No. 1/2, 147-152(1 Nov 1982).

From 6. international conference on fast ion beam spectroscopy; Quebec (Canada) (17 - 20 Aug 1981).

As an initial test of a new laser spectroscopy system placed on line to the UNISOR isotope separator, the hyperfine structure of ^{131}Xe II and ^{129}Xe II in their 5d ^{4}Dsub(7/2) and 6p ^{4}Psub(5/2) levels has been investigated along with isotope shifts for sup(128-131, 134, 136)Xe relative to ^{132}Xe. The method utilizes the resonant absorption of laser light collinear to the beam of approx.= 50 keV Xe ions from the isotope separator. The spectra were produced by scanning a ring dye laser over a small frequency range and continuously monitoring the absorption through subsequent fluorescence of the ^{4}Psub(5/2) level. Laser and other electronic drifts during the course of the measurements were small and were monitored through simultaneous absorption of a portion of the laser light in an I_2 cell. The measured hyperfine constants and isotope shifts are compared with earlier results and delta$\langle r^2 \rangle$ are deduced from the isotope shifts.

30653 **Radiative lifetime of the 6p^{4}P^{0}sub(5/2) level in Xe II.** Pegg, D.J.; Gaillard, M.L.; Bingham, C.R. (Tennessee Univ., Knoxville (USA); Oak Ridge National Lab., TN (USA)); Carter, H.K.; Mlekodaj, R.L. (UNISOR, Oak Ridge, TN (USA)). *Nuclear Instruments and Methods in Physics Research;* **202**: No. 1/2, 153-158(1 Nov 1982).

From 6. international conference on fast ion beam spectroscopy; Quebec (Canada) (17 - 20 Aug 1981).

We have used a new collinear laser-ion beam technique to measure the radiative lifetime of the 6p ^{4}Psub(5/2)^0 level in Xe II. Our result of 7.95 +- 0.16 ns is in disagreement with previous results. The appartus was tested by making a similar measurement on the 6p ^{2}Psub(3/2) level in Ba II whose lifetime is well established. We found good agreement with the accepted value in this case.

30654 **Temperature dependence of the anomalous muonium hyperfine interaction and depolarization rate in silicon.** Blazey, K.W. (I.B.M. Research Lab., Zuerich, Switzerland); Brown, J.A.; Cooke, D.W.; Dodds, S.A.; Estle, T.L.; Heffner, R.H.; Leon, M.; Vanderwater, D.A. *Muon SR Newsletter;* No. 25, 1126-1145(15 Jun 1981).

The temperature dependence of the anomalous muonium hyperfine interaction has been measured in silicon between 5 K and 150°K. The hyperfine parameters are observed to decrease with increasing temperature. This is argued to result from interaction of the anomalous muonium center with the silicon host phonons. Above 120°K a rapid increase of the depolarization rate of the anomalous muonium with temperature is observed; these data are consistent with a Raman process causing the increased depolarization.

30655 **Photodissociative ionization of amorphous ice.** Rosenberg, R.A. (Michelson Lab., China Lake, CA); Rehn, V.; Jones, V.O.; Green, A.K.; Parks, C.C.; Loubriel, G.; Stulen, R.H. *Chemical Physics Letters;* **80**: No. 3, 488-494(15 Jun 1981). Contract AC04-76DP00789.

Within the energy range 17 $\leqq$ h nu $<$ 35 eV, the ionic species desorbed and their excitation spectra are reported. The only positive ion desorbed is H^+. A model for the surface is suggested which explains the absence of OH^+ desorption. The desorption mechanisms are discussed in terms of an energy analysis.

30656 **Development of theoretical methodology for large molecules.** Maggiora, G.M.; Christoffersen, R.E.; Yoffe, J.A.; Petke, J.D. (Univ. of Kansas, Lawrence). *Annals of the New York Academy of Sciences;* **367**: 1-16(22 May 1981).

A major advantage of the use of floating spherical Gaussian or vitals (FSGO) is the extreme rapidity with which the necessary quantum mechanical integrals can be evaluated. This advantage has been exploited in several quantum mechanical procedures for molecular electronic structure calculations, as described below. Several other properties of these functions have also been exploited, and have led to the development of semiclassical point charge and harmonic oscillator models capable of describing first and second order electromagnetic properties and intermolecular forces with reasonable accuracy in all cases and with considerably better accuracy than much more elaborate theoretical procedures in some cases. These applications are also described below. The primary intent of the current paper is to present an overview of some of the uses of FSGOs in the study of molecular electronic structure and properties and to indicate possible directions for future applications. No attempt will be made to include all possible applications. Rather, those applications of interest to the authors have been stressed. Hopefully, this paper will further stimulate the development of additional uses of these remarkable functions.

30657 **Comparison of scattering of low energy K^+ and Ar^+ from the Au(110) surface.** Overbury, S.H. (Oak Ridge National Lab., TN). *Surface Science;* **112**: 23-37(1981). Contract W-7405-ENG-26.

Angle resolved low energy ion scattering measurements on clean, reconstructed Au(110) using both K^+ and Ar^+ as probe ions are compared. Computer simulation results indicate that the backscattering of K and Ar are similar, but the observed energy and angular distributions of scattered K^+ and Ar^+ ions are different in almost every detail due to preferential neutralization of the Ar^+. The absolute intensities obtained for backscattered Ar^+ are more than three orders of magnitude lower than for K^+, making the alkali ion a far more sensitive probe. The Ar^+ energy distributions are distorted by preferential neutralization so that the strong multiple scattering features observed in the K^+ spectrum are absent in the Ar^+ spectrum. Striking differences between Ar^+ and K^+ are observed in the dependence of the scattering upon incident energy, incident azimuthal angle, and total scattering angle. The results are discussed with reference to the use of ion scattering as a probe of surface structure.

30658 **Long range interaction between a He atom and a semiconductor surface.** Vidali, G.; Cole, M.W. (Pennsylvania State Univ., University Park). *Surface Science;* **107**: L374-L378(1981). Contract AC02-79ER10454.

The dispersion interaction between a He atom and a solid has the form $V \sim C_3 z^{-3}$ at large distance. We calculate the value of C_3 for several cases (Ge, Si, GaAs, and diamond) using experimental results for $\epsilon_2(\omega)$. The model dielectric function of Brecken-

ridge, Shaw and Sher is found to yield good agreement with the value of C_9 obtained from experimental data.

30659 **Comments on the surface-excitation model.** Krohn, V.E. (Argonne National Lab., IL). *Surface Science;* **111**: L744-L746(1981).

Peter Williams has proposed a new theory of the secondary-ion emission process based on a model which he calls the surface-excitation model. A particularly interesting feature of this model is that the effective temperature of the excited surface atoms may fall with time after the impact of the primary ion. This paper gives an argument for this part of the model which is considerably simpler and may be more robust. The comparison of this part of the model with the available experimental data is also discussed but the comparison is sharply limited by the scantiness of the data.

30660 **Silicon $L_{2,3}VV$ Auger Lineshape and oxygen chemisorption study of Pd_4Si.** Bader, S.D. (Argonne National Lab., IL); Richter, L.; Brodsky, M.B.; Brower, W.E.; Smith, G.V. *Solid State Communications;* **37**: 729-732(1981).

The Si $L_{2,3}VV$ Auger Lineshape for Pd_4Si was measured and found to be in good agreement with the self-fold of the Si partial density of states model calculated by Riley et al. Oxygen chemisorption altered both the Auger lineshape and the HeI photoemission spectrum, especially near the Fermi energy.

30661 **Negative ions of polyatomic molecules.** Christophorou, LG. (Oak Ridge National Lab., TN). *Environmental Health Perspectives;* **36**: 3-32(Nov 1980). Contract W-7405-ENG-26.

In this paper general concepts relating to, and recent advances in, the study of negative ions of polyatomic molecules are discussed with emphasis on halocarbons. The topics dealt with in the paper are as follows: basic electron attachment processes, modes of electron capture by molecules, short-lived transient negative ions, dissociative electron attachment to ground-state molecules and to hot molecules (effects of temperature on electron attachment), parent negative ions, effect of density, nature, and state of the medium on electron attachment, electron attachment to electronically excited molecules, the binding of attached electrons to molecules (electron affinity), and the basic and the applied significance of negative-ion studies.

30662 **Angular momentum in ion-molecule reactions.** Meisels, G.G.; Verboom, G.M.L.; Weiss, M.J.; Hsieh, T.C. (Univ. of Nebraska, Lincoln). *Journal of the American Chemical Society;* **101**: No. 24, 7189-7195(1979). Contract AC02-76ER02567.

The long-range attractive forces which dominate ion-neutral reactions lead to angular momentum distributions peaking at much higher values than in neutral systems, and therefore much longer angular momentum effects may be anticipated. Angular momentum may be expected to significantly alter overall product distribution when competing paths differ. Such effects can certainly be expected to be largest where one of the reaction paths is loss of a hydrogen atom. It is precisely in such fragmentations that transition state theory has in the past found it necessary to employ tight transition states to obtain agreement with experiments. This suggests that models based purely on phase space arguments which neglect the nature and effect of the critical reaction complex, maybe inadequate. Therefore, a model and a formalism has been developed based on Rice-Ramsperger-Kassel-Marcus theory which is believed to be particularly suitable for the study of angular momentum effects. While it is applied here to the evaluation of branching ratios of competitive fragmentation pathways, in accord with interest in the effect of angular momentum on the overall reaction chemistry, the approach may also be modified to calculate other parameters. The model has been tested with fragmentation of $C_4H_8^+$ prepared in two distributions of rotational states but with nearly identical total energy.

6404 Fluid Physics

30663 **(CEA-CONF—6155) Introduction to the Jastrow theory of a dense Fermi system.** Ripka, G. (CEA Centre d'Etudes Nucleaires de Saclay, 91 - Gif-sur-Yvette (France)). Nov 1981. 13p. (CONF-8110235—1). NTIS (US Sales Only), PC A02/MF A01. Order Number DE83700181.

From Workshop on nuclear physics; Trieste, Italy (4 Oct 1981).

An overwiew is given of the theory of a strongly interacting dense system as liquid ^{3}He. The use of Jastrow wavefunction is explained in the simplest models which bear relevance to actual liquid ^{3}He.

30664 **Elementary excitations in liquid ^{3}He.** Skoeld, K. (Studsvik Science Research Lab., Nykoeping, Sweden); Pelizzari, C.A. *Philosophical Transactions of the Royal Society of London, Series B: Biological Sciences;* **290**: 605-616(1980).

The two isotopes of helium offer unique opportunities to test fundamental theories of quantum fluids. In liquid ^{4}He, a Bose liquid, the elementary excitations have been studied extensively over the last two decades by neutron inelastic scattering. Similar studies of liquid ^{3}He, the Fermi liquid counterpart of liquid ^{4}He, have become possible only recently. From the results obtained so far for normal liquid ^{3}He, the existence of zero sound as a well defined density excitation at finite wavevectors (q approx. = to q/sub F/) and finite temperatures (T approx. = to T/sub F/) has been verified and the spin fluctuation spectrum has been measured. By comparing the neutron scattering results for the density fluctuation spectrum with R.P.A. calculations with generalized polarization potentials, important information has been obtained about the effective spin-symmetric interaction between ^{3}He atoms. The spin fluctuation spectrum is in agreement with the paramagnon model if a value close to unity is assumed for the contact dimensionless paramagnon parameter I. This implies that the nuclear spin system in normal liquid ^{3}He is close to ferromagnetic.

6450 High Energy Physics

30665 **(UCLA—10-P25-73) UCLA Particle Physics Research Group annual progress report.** Nefkens, B.M.K. (California Univ., Los Angeles (USA). Dept. of Physics). Aug 1981. 146p. NTIS, PC A07/MF A01. Order Number DE83010044.

Portions are illegible in microfiche products.

The objectives, basic research programs, recent results and continuing activities of the UCLA Particle Physics Research Group are presented. The objectives of the research are to discover, to formulate, and to elucidate the physics laws that govern the elementary constituents of matter and to determine basic properties of particles. A synopsis of research carried out last year is given. The main body of this report is the account of the techniques used in our investigations, the results obtained, and the plans for continuing and new research.

6451 Particle Interactions And Properties - Experimental

REFER ALSO TO CITATION(S) 30271, 30607, 30665, 30665

30666 **(BNL—32783) Monte Carlo simulation of high p/sub T/ jets.** Paige, F.E.; Protopopescu, S.D.; Weygand, D.P. (Brookhaven National Lab., Upton, NY (USA)). 1983. Contract AC02-76CH00016. 11p. (CONF-830224—2). NTIS, PC A02/MF A01. Order Number DE83010857.

From DPF workshop on collider detectors: present capabilities and future possibilities; Berkeley, CA, USA (28 Feb 1983).

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We discuss the properties of high p/sub T/ jets expected at high-energy hadron colliders.

30667 (CONF-8106280—1) Could (+1/3e) stable particles be consistent with present observations. A search for fractionally charged particles with an all-electrostatic system. Schiffer, J.P. (Argonne National Lab., IL (USA)). 1981. Contract W-31-109-ENG-38. 8p. NTIS, PC A02/MF A01. Order Number DE83009670.

From Quark searchers conference; San Francisco, CA, USA (5 Jun 1981).

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Various experimental searches for free quarks are discussed and loopholes are pointed out. Current and future plans are outlined. (WHK)

30668 (DOE/ER/40033—36) Diffraction dissociation and the direct hadronic interaction of the photon. Goulianos, K. (Rockefeller Univ., New York (USA)). 1983. Contract AC02-81ER40033. 13p. NTIS, PC A02/MF A01. Order Number DE83008891.

Portions are illegible in microfiche products.

We report a measurement of the inclusive diffraction dissociation cross section of ~ 100 GeV photons on hydrogen; we test the finite mass sum rule and, comparing with pion dissociation data, we test factorization. Our results are interpreted as providing a measurement of the direct, non vector meson dominance hadronic interaction of the photon.

30669 (DOE/ER/40085—1) Study of diquark fragmentation into Λ and Y^{*+} nu n and nu p interactions. Chang, C.C.; Mann, W.A.; Napier, A. (Tufts Univ., Medford, MA (USA); Illinois Inst. of Tech., Chicago (USA); Maryland Univ., College Park (USA); State Univ. of New York, Stony Brook (USA); Tohoku Univ., Sendai (Japan)). [nd]. Contract AC02-83ER40085. 12p. NTIS, PC A02/MF A01. Order Number DE83008893.

We apply a new method to determine the probability of the uu diquark from nu p interactions fragmenting as independent quarks. In particular, by assuming that all Λ's which do not come from Y^{*+}, N^{*+} or charmed baryons must come from independent fragmentation, we show this probability to be about 50%. We also provide information from nu n interactions on the fragmentation of ud diquarks into Λ's, and from this determine the probability of capturing a strange quark from the sea in the target region to be tau/sub s/ = 0.051 +- 0.013, about half the value found in the current region, γ/sub s/ = 0.12 +- 0.02. Overall Λ production rates in nu n and nu p reactions are (7.0 +- 0.8)% and (7.0 +- 1.2)% respectively, when cuts of W > 4 GeV and x/sub B/ > 0.2 are made on the data.

30670 (ITEF—111(1981)) Neutrino properties and interactions (1977-1980). Multileptonic events. Tsukerman, I.S. (Gosudarstvennyj Komitet po Ispol'zovaniyu Atomnoj Ehnergii SSSR, Moscow. Inst. Teoreticheskoj i Ehksperimental'noj Fiziki). 1981. 57p. (In Russian). NTIS (US Sales Only), PC A04/MF A01. Order Number DE83701518.

Neutrino experiments resulting in several charged leptons produced in a final state are reviewed for the period from 1977 to 1980. The experiments have been carried out at practically all proton accelerators of the world. The total figure of registered multileptonic events outnumbered a thousand. All the experiments are broken into 6 groups : (1) the $\mu^{-+}\mu^{+-}$ events at facilities with electronic equipment; (2) the $\mu^{-+}l^{+-}$ events in bubble chambers; (3) final data on the $\mu^{-+}l^{+-}$ (V^0) events (where V^0 stands for neutral strange particles); (4) the μ^-l^- events; (5) the three-muon events, and (6) the four- leptonic events. Data on the strange particle multiplicities in the events are presented as well as data on antiquark sea derived therefrom. Theoretical interpretations of the experimental data are given within each group of experiments.

30671 (JINR—E-1-81-739) Charged particle multiplicity distribution in anti pp interactions at 22.4 GeV/c. Batyunya, B.V.; Boguslavsky, I.V.; Gramenitsky, I.M. (Joint Inst. for Nuclear Research, Dubna (USSR)). 1981. 8p. NTIS (US Sales Only), PC A02/MF A01. Order Number DE83701536.

Data are presented on topological cross sections for charged particle production in antiproton-proton inelastic interactions at 22.4 GeV/c obtained by scanning more than 260000 pictures from the bubble chamber "LUDMILA". Processing and unification of the results obtained at different laboratories, that permitted the effect of systematic errors to be substantially reduced, are described. The characteristics of the anti pp -annihilation process are obtained from the difference in the topological anti pp and pp cross sections.

30672 (JINR—R-1-81-504) Search for cumulative eta mesons in the πsup(-)Cu→eta(180deg)X reaction at 3.8 GeV/c. Arkhipov, V.V.; Aslanyan, P.Zh.; Astvatsaturov, R.G.; Kramarenko, V.A.; Malakhov, A.I.; Melkumov, G.L.; Plyashkevich, S.N.; Khachaturyan, M.N.; Khudaverdyan, A.G.; Chvyrov, A.S. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of High Energy). 1981. 6p. (In Russian). NTIS (US Sales Only), PC A02/MF A01. Order Number DE83701510.

2γ-event energy spectrum has been measured within the 0<=T<=300 MeV kinetic energy range. 2γ-quanta from the eta meson decay were produced on copper nuclei by 3.8 GeV/c π^--mesons at 180 deg angle in laboratory system. The 2γ-event spectrum in the mass interval 549+-50 MeV is presented as invariant cross section $Ex(d^3\sigma/d\ anti\ p^3)$, where E and p are total energy and 2γ-event momentum, respectively. On the basis of experimental data the upper boundary for invariant cross section of meson generation in the π^- Cu→eta (180 deg)X reaction is determined with the 90% level of reliability.

30673 (KFK—3405-B) Investigation on the jet structure of hadronic events with a high energy photon. Knapp, J. (Kernforschungszentrum Karlsruhe G.m.b.H. (Germany, F.R.). Inst. fuer Kern- und Teilchenphysik). Oct 1982. 85p. (In German). NTIS (US Sales Only), PC A05/MF A01. Order Number DE83750314.

Hadronic events including geometrically isolated high energy photons have been investigated by the CELLO detector at PETRA at $\sqrt{s}$=22 and $\sqrt{s}$=34 GeV. At $\sqrt{s}$=34 GeV the predominant source of these events was found to be initial state bremsstrahlung (75%). At $\sqrt{s}$=22 GeV are only 57% of the isolated photons coming from bremsstrahlung. The jet structure of these events has been tested using the jet measures thrust, sphericity, psub(T) and nsub(ch) as function of the energy of the photon. The agreement with QED and QCD predictions is good.

30674 (MPI-PAE/Exp.El.—110) Jets at PETRA. Oberlack, H. (Max-Planck-Institut fuer Physik und Astrophysik, Muenchen (Germany, F.R.). Inst. fuer Physik). Sep 1982. 64p. Available from Max-Planck-Institut fuer Physik und Astrophysik, Muenchen (Germany, F.R.).

From 2. international conference on physics in collisions; Stockholm (Sweden) (2 - 4 Jun 1982).

Recent results on formation and fragmentation of partons studied at PETRA by the five experiments CELLO, JADE, MARK J, PLUTO and TASSO are presented. Breaking of scale invariance in charged hadron production is observed to be compatible with QCD expectations. Hints of scale breaking are seen for individual particle species. π^0 inclusive spectra are found to be softer than πsup(+-) spectra, there are more Ksup(+-) than K^0, and baryon production is found to be copious. Gluon jets seem to be broader than quark jets as predicted by the Lund M.C. simulator. Long range charge correlations are confirmed and the average charge of quark jets is determined. Four-jet production is observed at a rate compatible with QCD predictions. Energy weighted angular correlations are compared to QCD model calculations. Finally it is found that the determination of the strong coupling constant depends on the type of fragmentation model used.

30675 Interaction of kaons with nucleons and nuclei. Dover, C.B. (Brookhaven National Lab., Upton, NY (USA)); Walker, G.E. (Indiana Univ., Bloomington (USA)). *Physics Reports: A Review Section of Physics Letters (Section C);* **89**: No. 1, 1-177(Sep 1982).

With 366 refs.

We review the status of experimental and theoretical investigations of kaon-nucleon and kaon-nucleus interactions and suggest

areas likely to be of interest as the field of kaon-nuclear physics develops. The properties of K^+N and K^-N amplitudes are discussed in detail. For low energy, the K^+N interaction is weak and slowly varying with energy. Therefore the K^+ should be an important source of information regarding nuclear structure. The overlap and complementarity of the K^+ as a nuclear probe are discussed in the context of other intermediate energy projectiles. In order to utilize Ksup(+-) beams for nuclear studies, more precise low and medium energy Ksup(+-)N data are also required, K^- nucleus reactions, primarily because of the coupling to strangeness -1 baryons (Λ, Σ) and Ysup(*) resonances, are expected to be more complicated than those of the K^+. For the further study of hypernuclei and Ysup(*) resonances in nuclei, intense variable energy K^- beams of good resolution are shown to be crucial. With such beams the study of hypernuclei could parallel the rich history of the study of nuclear structure. Besides providing a laboratory for studying hyperon-nucleon and hyperon-hyperon interactions the addition of an impurity (hyperon) into the many-baryon system can provide additional tests of the existing models of the nucleus. We examine the many facets of kaon-nuclear physics which have been explored with current techniques and existing facilities. However, we argue that the full realization of the potential of this field requires a 'kaon factory'.

30676 Search for neutrino oscillations at Fermilab. Baker, N.L.; Bregman, M.; Caroumbalis, D. (Brookhaven National Lab., Upton, NY). pp 295-300 of Gauge theories, massine neutrinos, and proton decay. Kursunogluy, B.; Perlmutter, A. New York, NY; Plenum (1981).

From Orbis scientiae conference; Fort Lauderdale, FL, USA (19 Jan 1981).

This article reports on a search for neutrino oscillations, particularly transformations of muon neutrinos into electron or tau neutrinos. After a discussion of the experimental procedure, several possible improvements are discussed. One suggestion is to investigate the frequency of electron events with varying neutrino energies, and another is to obtain data from 100 GeV protons, instead of the 400 GeV beam actually obtain data from 100 GeV protons, instead of the 400 GeV beam actually used. Each of these would permit an increase in sensitivity.

6452 Particle Interactions And Properties - Theoretical

REFER ALSO TO CITATION(S) 30675, 30708, 30709

30677 (ANL-HEP-CP—82-68) Massive lepton pair production: what has QCD done to the classical Drell-Yan model. Berger, E.L. (Argonne National Lab., IL (USA)). Nov 1982. Contract W-31-109-ENG-38. 50p. (CONF-8210113—2). NTIS, PC A03/MF A01. Order Number DE83009517.

From American Physical Society meeting on pariticles and fields; College Park, MD, USA (28 Oct 1982).

Portions are illegible in microfiche products.

A report is presented of recent experimental and theoretical progress in studies of the production of massive lepton pairs in hadronic collisions. Among the topics discussed are deviations from scaling, the status of the proofs of factorization in the parton model, higher-order terms in the QCD expansion, the discrepancy between measured and predicted yields (K factor), high-twist terms, soft gluon effects, and transverse momentum distributions.

30678 (ANL-HEP-CP—82-72) Hadronic production of massive lepton pairs. Berger, E.L. (Argonne National Lab., IL (USA)). Dec 1982. Contract W-31-109-ENG-38. 63p. (CONF-8210107—4). NTIS, PC A04/MF A01. Order Number DE83008928.

From Workshop on Drell-Yan processes; Batavia, IL, USA (7 Oct 1982).

A review is presented of recent experimental and theoretical progress in studies of the production of massive lepton pairs in hadronic collisions. I begin with the classical Drell-Yan annihilation model and its predictions. Subsequently, I discuss deviations from scaling, the status of the proofs of factorization in the parton model, higher-order terms in the perturbative QCD expansion, the discrepancy between measured and predicted yields (K factor), high-twist terms, soft gluon effects, transverse-momentum distributions, implications for weak vector boson (W^{+-} and Z^0) yields and production properties, nuclear A dependence effects, correlations of the lepton pair with hadrons in the final state, and angular distributions in the lepton-pair rest frame.

30679 (ANL-HEP-CP—83-05) Measurement of α/sub s/. Clavelli, L. (Argonne National Lab., IL (USA)). Jan 1983. Contract W-31-109-ENG-38. 29p. (CONF-830134—2). NTIS, PC A03/MF A01. Order Number DE83009522.

From Orbis scientiae conference; Miami, FL, USA (17 Jan 1983).

We point out that a number of QCD tests, relatively free of obvious nonperturbative corrections and other theoretical problems, are now available in e^+e^- annihilation. By focusing on these tests, one can see the beginning of a confirmation of the running of the strong-coupling constant predicted by the renormalization group.

30680 (ANL-HEP-PR—82-18) Important high-twist contribution to prompt single-photon production. Berger, E.L. (Argonne National Lab., IL (USA)). Feb 1982. Contract W-31-109-ENG-38. 30p. NTIS, PC A03/MF A01. Order Number DE83009521.

Quantitative predictions are presented for a specific hard-scattering reaction $\pi N \rightarrow \gamma X$ in which both the incident meson and the produced prompt photon couple directly in the QCD amplitude. The process leads to a highly constrained class of events at large p/sub T/ in which the photon momentum is balanced by that of a recoil quark jet, with no spectator jet of final-state particles emerging along the beam axis. Normalized absolutely in terms of the electromagnetic form factor of the pion, F/sub π/(Q^2), the cross section provides a lower bound on the total p/sub T/$^{-6}$ high twist contribution to the inclusive prompt-photon yield.

30681 (IAE—3434/1) Mass relations in systems of SU (n) symmetric particles with account for multiparticle forces. Bychkov, A.S.; Gaponov, Yu.V. (Gosudarstvennyj Komitet po Ispol'zovaniyu Atomnoj Ehnergii SSSR, Moscow. Inst. Atomnoj Ehnergii). 1981. 15p. (In Russian). NTIS (US Sales Only), PC A02/MF A01. Order Number DE83700232.

Mass operators are constructed on irreducible representations of SU(n) groups including the higst Casi.mir operators. By the rearrangement group methods their relation to multiparticle potentials in the identical particle systems is established. As an example application of a developed scheme for detailed description of SU(3)-multiplets in the hypernuclear system with account for SU(3) symmetry breaking is considered.

30682 (IC—79/2) Few-body system and particle resonances. Mubarak, A. (International Centre for Theoretical Physics, Trieste (Italy)). Jan 1979. 7p. NTIS (US Sales Only), PC A02/MF A01. Order Number DE83701487.

Techniques of few-body system in nuclear physics are exploited to analyze the spectrum of the T resonance and its family. Their relation to nuclear resonances are established so as to apply few-body dynamical techniques in the dynamical structure of particles carrying the truth quantum number.

30683 (IFVE-OTF—81-110) Inclusive photoproduction of charmed hadrons in VMD. Likhoded, A.K.; Slabospitsky, S.R.; Tolstenkov, A.N. (Gosudarstvennyj Komitet po Ispol'zovaniyu Atomnoj Ehnergii SSSR, Serpukhov. Inst. Fiziki Vysokikh Ehnergij). 1981. 18p. NTIS (US Sales Only), PC A02/MF A01. Order Number DE83701508.

On the basis of the vector meson dominance model completed with the fusion model a mechanism of charmed hadron photoproduction has been developed. In the framework of this mechanism the total cross sections and inclusive spectra for charmed hardon photoproduction have been calculated. Anti D-meson yields have been obtained to be higher than D-meson ones at low energies, which is connected with pair production of anti D meson and Λsub(c) baryons.

30684 (IPNO-TH—81-41) Single Δ production contribution to proton inelasticity parameters. Cote, J.; Lacombe, M.; Loiseau, B.; Cottingham, W.N. (Paris-11 Univ., 91 - Orsay (France). Inst. de Physique Nucleaire). Oct 1981. 28p. NTIS (US Sales Only), PC A03/MF A01. Order Number DE83701526.

We here present a meson exchange calculation of the nucleon-nucleon peripheral partial wave inelasticity parameters below 1 GeV lab kinetic energy. These theoretical estimates if used as constraints in future nucleon-nucleon phase shift analyses should reduce the ambiguities in the inelastic region.

30685 (ITEP—13(1982)) Dynamical model of the real part of the forward scattering amplitude. Levintov, I.I. (Gosudarstvennyj Komitet po Ispol'zovaniyu Atomnoj Ehnergii SSSR, Moscow. Inst. Teoreticheskoj i Ehksperimental'noj Fiziki). 1982. 8p. NTIS (US Sales Only), PC A02/MF A01. Order Number DE83700233.

The model is developed in which te real part of the elastic scattering amplitude is considered as one of t channels of diffraction dissociation. In terms of this model, the observed positivity Ref(0) at E> or approximately 10^2 GeV results in a conclusion that transparency of hadrons increases with the energy increase at large transverse distances ($Z_t > 2/m$) between valent quarks.

30686 (ITEP—36(1982)) U(1)-problem, THETA-term and CP-violation. Shabalin, E.P. (Gosudarstvennyj Komitet po Ispol'zovaniyu Atomnoj Ehnergii SSSR, Moscow. Inst. Teoreticheskoj i Ehksperimental'noj Fiziki). 1982. 12p. NTIS (US Sales Only), PC A02/MF A01. Order Number DE83700184.

The σ-model including the physical fields only and possessing the algebraic properties of the quantum chromodynamics (QCD) is considered. An expression for CP-odd part of σ- model Lagrangian which reflects the existence of theta-term in the QCD Lagrangian is obtained in terms of physical fields. A connection between U(1) problem resolution and physical CP-violation is established.

30687 (ITEP—108(1981)) Differences in hadronic cross-sections and the residues of secondary reggeons in the quark-gluon model for strong interactions. Kaidalov, A.B.; Volkovitsky, P.E. (Gosudarstvennyj Komitet po Ispol'zovaniyu Atomnoj Ehnergii SSSR, Moscow. Inst. Teoreticheskoj i Ehksperimental'noj Fiziki). 1981. 23p. NTIS (US Sales Only), PC A02/MF A01. Order Number DE83701509.

In the framework of the quark-gluon picture for strong interactions based on the topological expansion and the string model, the relations between t differences of hadronic cross- section are obtained. The system of equations for the contribution of secondary reggeons (rho, ω, f, A_2 and phi and f' poles) to the elastic scattering amplitudes for arbitrary hadrons is derived. It is shown that this system has a factorized solution and the secondary reggeon residues for all hadrons are expressed in terms of the universal function g(t). The model predictions are in a good agreement with experimental data.

30688 (ITEP—142(1981)) Dynamics of the coupled quark and hadronic channels. Simonov, Yu.A. (Gosudarstvennyj Komitet po Ispol'zovaniyu Atomnoj Ehnergii SSSR, Moscow. Inst. Teoreticheskoj i Ehksperimental'noj Fiziki). 1981. 48p. NTIS (US Sales Only), PC A03/MF A01. Order Number DE83701517.

An extensive and detailed exposition is given of a new approach to the hadron-hadron dynamics at intermediate energies ($\sqrt{s}$ < several GeV) based on the inclusion of the quark compound bag (QCB) channels and the Jaffe-Low P matrix analysis. Two alternative methods are used: (1) the coupled QCB-hadrons channel formalism and (2) a nuclear-cluster-type approach, to derive essentially analogous final equations. The connection between P-matrix and S-matrix poles and between P-matrix poles and QCB eigenvalues is studied. The quark contents (i.e. the QCB percentage) of any quark-hadronic state can be defined unambigously and is shown to be around 15% for the deuteron and of the order of 50% for nuclear matter. Some recent results of the P matrix analysis are reviewed together with a new analysis of the S wave NN scattering. A conclusion is made, that the QCB states, even if wide and not seen as resonances, play a dominant role in the dynamics of hadrons at intermediate energies.

30689 (JINR—1-81-746) Verification of the hypothesis of Regge trajectory factorization in $\pi p p \to \pi^+(\pi^-\pi^0) + X$ reactions at 5 GeV/c. Antosh, Ya.; Shandor, L.; Rumyantsev, V.S.; Rusakovich, N.A. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Problems). 1981. 7p. (In Russian). NTIS (US Sales Only), PC A02/MF A01. Order Number DE83700234.

Submitted to the Journal Sov. J. Nucl. Phys.

Results of comparison are presented between the experiment and linear relations between differential cross sections of inclusive reactions in the region of target fragmentation within the framework of approach based on the Muller-Regge phenomenology and on the hypothesis of the Regge trajectory factorization. The relation between the differential cross sections of the $\pi^- \to \pi^0 + X$ reaction for two different energy values has been derived. The differential cross sections of the $\pi^- p \to \pi^+/\pi^-/\pi^0 + X$ reactions have been calculated at 5 GeV/c on the basis of the above relations from data on the reactions of $K^+ p \to \pi^{+-} + X$ at 32 GeV/c, $\pi^+ p \to \pi^0 + X$ at 10.5 GeV/c and $K^- p \to \pi^{+-} + X$ at 8.25 GeV/c. There is an agreement between calculated and experimental differential cross sections of the $\pi^- p \to \pi^+/\pi^-/\pi^0 + X$ at 5GeV/c.

30690 (JINR—E-2-81-810) Renormalization and short-distance properties of gauge invariant gluonium and hadron operators. Dorn, H.; Robaschik, D.; Wieczorek, E. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1981. 15p. NTIS (US Sales Only), PC A02/MF A01. Order Number DE83700235.

Gauge invariant nonlocal gluonium operators constructed with the help of phase factors in different representations are investigated. Renormalization and short distance properties turn out to be independent of representations used. The same problem is studied for hadron operators where the renormalization of the gauge invariant baryon operator is obtained. Furthermore composite operators distinguished by absence of renormalization are discussed.

30691 (JINR—E-2-81-832) Higher order corrections for the running coupling constant of QCD and an effective potential of the one-gluon exchange in t- and s-channels. Linkevich, A.D.; Savrin, V.I.; Skachkov, N.B. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1982. 16p. NTIS (US Sales Only), PC A02/MF A01. Order Number DE83700236.

A simple formula is found, that approximates the one-gluon exchange amplitude with the "running" coupling constant expressions with taking into account of one-, two-, and three- loop contributions and with its generalizations to the case of massive quarks. The obtained formula can be considered as an effective one-gluon exchange amplitude. To this amplitude there corresponds in the relativistic configurational representation a simple Coulomb-like potential, which permits exact solutions of a relativistic two-particle equation for the wave function.

30692 (JINR-R—2-81-710) Relativistic model of diffraction scattering. Barashenkov, V.S.; Zadorozhnyj, A.M.; Kostenko, B.F.; Shmakov, S.Yu. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Computing Techniques and Automation). 1981. 10p. (In Russian). NTIS (US Sales Only), PC A02/MF A01. Order Number DE83700237.

The relativistic generalization of Glauber theory for two interacting systems with an arbitrary number of constituents-nucleons or quarks is considered. Solutions of wave equation with relativistic harmonical potential being a generalization of three-dimensional Gaussian distributions are used as system t wave functions. The potential parameters are connected with the experimental data system masses and mean squared radii. A method giving an integral free expression for scattering amplitude is stated.

30693 **(JINR-R—4-81-774) Spin, masses and anomalous magnetic moments of charged leptons (the ring model).** Matora, I.M. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Neutron Physics). 1981. 4p. (In Russian). NTIS (US Sales Only), PC A02/MF A01. Order Number DE83700238.

The exact analytical expressions of the ring model particle parameters are obtained. The model has the following features. The uniformly distributed on a torus surface massless charge e is circulating with a constant azimuthal velocity βc and the magnetic flux through a ring is quantized and equal $PHI_0 = hc/2e$. It is shown that the total magnetic momentum always contains an anomalous part, except of one case when β approximately 1-e/PHI_0, and g-factor equals 2. For the electron case the calculated model spin, electromagnetic mass and g-2/2 with $\beta sub(e) = 0.9988392$ turned out to be $h/4\pi$, 0.5110035 MeV/c^2 and 1.1596523×10^{-3} respectively. The same quantities for muon with $\beta sub(\mu) = 0.9888455$ equal $h/4\pi$, 105.65946 MeV/c^2 and 1.165936×10^{-3}, i.e., the model parameters coincide with the measured ones for both particles.

30694 **(KMU-HEP—82-03) QCD jets in e^+e^--annihilation and the transition into hadrons.** Ritter, S. (Karl-Marx-Universitaet, Leipzig (German Democratic Republic). Sektion Physik). Mar 1982. 41p. NTIS (US Sales Only), PC A03/MF A01. Order Number DE83700239.

A model has been developed describing QCD jets in the leading logarithmic approximation (LLA) and the subsequent transition into hadrons via a chain decay model. Besides of the production of mesons, the model is also able to describe baryon production. Agreement with recent data from e^+e^--annihilation is found. This includes average multiplicities, average transverse momenta and transverse momentum distributions, longitudinal momentum distributions as well as particle production ratios π^{+-}:K^{+-}:p(antip), charge compensation probabilities and energy flux correlations. The model is compared to similar models developed by other authors.

30695 **(KMU-HEP—82-04) Second order QCD corrections to qantiq-annihilation into a lepton pair at large transverse momentum.** Perlt, H. (Karl-Marx-Universitaet, Leipzig (German Democratic Republic). Sektion Physik). Feb 1982. 24p. NTIS (US Sales Only), PC A02/MF A01. Order Number DE83700240.

The theta(α/sub s//sup 2/) correction is presented to quark-antiquark-annihilation into a lepton pair at large transverse momentum. The corresponding hadron cross section difference $d\sigma/d^4q(pantip\text{-}pp) \rightarrow e^+e^- + x$ (q is the momentum of the lepton pair system) has been calculated. The correction to this cross section difference is found to be large. This essentially agrees with recently published results by Ellis, Martinelli and Petronzio. Two important approximations are used: the invariant mass of the two-gluon-system is put to zero, and only valence-valence quark scattering is considered.

30696 **(LA-UR—83-841) Hyperon and hypernuclear physics with intense beams.** Gibson, B.F. (Los Alamos National Lab., NM (USA)). 1983. Contract W-7405-ENG-36. 12p. (CONF-830339—1). NTIS, PC A02/MF A01. Order Number DE83010079.

From Theoretical symposium on intense medium energy sources of strangeness; Santa Cruz, CA, USA (19 Mar 1983).

Portions are illegible in microfiche products.

A brief examination of progress in the study of hypernuclear physics and the hyperon-nucleon interaction is presented. The use of Λ-hypernuclei in the study of conventional (nonstrange) nuclei is explored. The status of the hyperon-nucleon force problem is reviewed. Anecdotal results are discussed for baryon numbers 4 and 13. Σ-hypernuclei are discussed. Production of S = -2 hypernuclei is mentioned.

30697 **(LAPP-TH—53) Rapidity spectra in proton-proton and proton-antiproton scattering up to 540 GeV in a dual parton model.** Aurenche, P.; Bopp, F.W. (Grenoble-1 Univ., 74 - Annecy (France). Lab. de Physique des Particules). Jan 1982. 14p. (SI—81-26). NTIS (US Sales Only), PC A02/MF A01. Order Number DE83700241.

Some recent data at the ISR and SPS colliders are discussed in terms of a multi-Pomeron exchange model formulated in the dual parton framework. Charged particle rapidity distributions, energy dependence of the central plateau, ratio of particle densities in proton-proton and antiproton-proton scattering and non diffractive multiplicities are successfully accounted for in the model.

30698 **Quark approach to Santilli's conjecture on hadronic structure.** Animalu, A.O.E. (Univ. of Nigeria, Nsukka). *Hadronic Journal;* **5**: No. 5, 1764-1773(Aug 1982). (CONF-820136—).

From 1. international conference on non-potential interactions and their Lie-admissible treatment; Orleans, France (5 Jan 1982).

Recently, Santilli conjectured that, because the so-called theorems of inconsistent quantization into Heisenberg's equations are activated when quarks are treated as physical point-particles, hadron phenomenology may demand different yet compatible models, namely: the established SU(3) classification of hadrons into multiplets and a different Bohr-type model of structure for each individual member of a multiplet, in which the quark hypothesis for hadronic constituents is to be abandoned ad replaced by a more general (Lie-admissible) notion of particle to express the state of mutual penetration of the wave packet of each constituent with those of the others. A quark approach to a Bohr model of hadronic bound states, in which such a state of mutual penetration of the strong charge volumes of the constituent quarks, occurs, is presented, the quarks being bound in a Yukawa-type central field approximated by its long-range part, $-g^2/r$, plus a meson mass term, in the limit $g^2 = 1$. A physical interpretation of the resulting hydrogenic-atom spectrum, based on an analogy with nuclear and atomic spectra is proposed and leads to a prediction of the mass ratio m/sub s//m/sub u/ of the strange to the light quarks in good agreement with the mass ratios of the members of the low-lying SU(3) multiplets.

30699 **Incompatibility of the quantum and relativity theories and a possible resolution.** Sachs, M. (State Univ. of New York, Buffalo). *Hadronic Journal;* **5**: No. 5, 1781-1801(Aug 1982). (CONF-820136—).

From 1. international conference on non-potential interactions and their Lie-admissible treatment; Orleans, France (5 Jan 1982).

This paper presents a comparison of the conceptual bases of the quantum theory and the theory of relativity, each considered as fundamental theories of elementary matter. From a study of the irreducible axiomatic bases of these respective approaches to elementary matter, it is concluded that they cannot peacefully co-exist because of logical incompatibility. Among the reasons discussed for this conclusion, one is the implication of the Hamiltonian form of quantum mechanics yielding an irreducible absolute frame of reference - that of the measuring apparatus - in the basic expression for the laws of elementary particles. This difficulty leads to logical inconsistency as well as a formulation of relativistic quantum field theory that is not demonstrably mathematically consistent. In spite of their logical incompatiability, it is argued that each of these theories logically requires the other, within its own framework. The conclusion is reached that, to make further progress in our understanding of elementary matter, it is necessary to abandon the axiomatic basis of one of these theories for the other, while keeping the formal structure of the abandoned theory as an accurate mathematical approximation (under special physical conditions) for a generalized form of the retained theory. An argument is presented for the author's retention of the theory of relativity as an authentic basis of elementary matter, and how its generalization is achieved by incorporating a fully (generally) covariant expression of the inertial manifestations of matter with its force manifestations.

30700 **Lie-admissible formulation of differential systems of even order.** Trostel, R. (Institut fuer Theoretische Physik, Berlin, Germany). *Hadronic Journal;* **5**: No. 5, 1893-1900(Aug 1982). (CONF-820136—).

From 1. international conference on non-potential interactions and their Lie-admissible treatment; Orleans, France (5 Jan 1982).

Using Santilli's construction of the Lie-admissible formulation of dynamical systems, and Whittaker's generalized theory of Hamiltonian systems dealing with Lagrangians depending on the

derivatives of the state variables to an arbitrary but finite order, we present a Lie-admissible formulation for materials of differential type of even order.

30701 **Foundations of the Lie-admissible Fock space of the hadronic mechanics.** Jannussis, A. (Univ. of Patras, Greece); Brodimas, G.; Sourlas, D.; Streclas, A.; Siafaricas, P.; Papaloucas, L.; Tsangas, N. *Hadronic Journal;* 5: No. 5, 1923-1947(Aug 1982). (CONF-820136—).

From 1. international conference on non-potential interactions and their Lie-admissible treatment; Orleans, France (5 Jan 1982).

In the present paper we study the case of coupling harmonic oscillators in hadronic mechanics. The non-canonical commutation relations of position and momentum operators are reduced, by Fock representation, to the known relations of Q-algebra. In the general case: $(A,A^+) = AA^+ - A^+QA$, of a Lie-admissible algebra, where Q is an operator, we can define new Fock creation and annihilation operators, which describe some particles only under certain conditions, which must be fulfilled by the operator Q. When we have a simple hadronic harmonic oscillator, the Q is a scalar less than 1, and we have energic saturation in eigenvalues spectrum. In this case the generalized uncertainty principle of Heisenberg is valid have energic saturation in eigenvalues spectrum. In this case the generalized uncertainly principle of Heisenberg is valid according to Santilli's theory. Finally, the coherent states of annihilation operator A are given and the Weyl displacement operator is generalized in Q-algebra.

30702 **Foundations of the hadronic generalization of the atomic mechanics. I. Generalization of Heisenberg's and Schroedinger's representations.** Santilli, R.M. (Inst. for Basic Research, Cambridge, MA). *Hadronic Journal;* 5: No. 4, 1194-1276(Jun 1982). (CONF-820136—). Contract AC02-80ER10651.

From 1. international conference on non-potential interactions and their Lie-admissible treatment; Orleans, France (5 Jan 1982).

This paper deals with the part of of the Hadronic Mechanics called of Lie-isotopic type, which: (1) is conceived for the exterior strong non-Hamiltonian treatment; (2) is based on the isotopic generalization of the associative algebra of operators on a Hilbert space; and (3) admits as a classical limit the recently achieved Birkhoffian generalization of the Hamiltonian Mechanics. We first review the Hadronic-isotopic covering of Heisenberg's representation with particular reference to the generalization of: Heisenberg's equations; canonical commutation rules; canonical quantization; Heisenberg's uncertainty principle; Planck's constant; Galilei's relativity; and the representation theory. A possible, single, unifying postulate for the covering theory is introduced. We then pass to the construction of the corresponding generalization of Schroedinger's representation. For this purpose, we first construct the Birkhoffian generalization of the Hamilton-Jacobi theory for local non-Hamiltonian systems. We then show that the latter theory admits a consistent quantization into a generalization of Schroedinger's equations. Some essential properties of the emerging hadronic generalization of the atomic wave theory, are presented. In particular, we identify the general solution of the hadronic wave packets under the most general possible local Hamiltonian and non-Hamiltonian forces, which has no counterpart in the Atomic Mechanics.

30703 **Foundations of the hadronic generalization of the atomic mechanics. II. Modular-isotopic Hilbert space formulation of the exterior strong problem.** Myung, H.C.; Santilli, R.M. (Inst. of Basic Research, Cambridge, MA). *Hadronic Journal;* 5: No. 4, 1277-1366(Jun 1982). (CONF-820136—). Contract AC02-80ER10651.

From 1. international conference on non-potential interactions and their Lie-admissible treatment; Orleans, France (5 Jan 1982).

This paper is devoted to a first formulation of the axiomatic Hilbert space foundations of the branch of the Hadronic Mechanics dealing with the exterior treatment of strong non-Hamiltonian systems, and which admits a Lie-isotopic algebraic character. In particular, we are interested in generalizing the conventional eigenvalue equations of the Atomic Mechanics into the broadest possible equations which are permitted by an associative algebra of opeators on a one-sided, modular, Hilbert space. The objective is made possible by the isotopic generalization of the associative algebra of operators A, B, ... on a Hilbert space, characterized by the product A*B - ATB, where T is a fixed, bounded, and nonsingular operator. By using the T-isotopic product, we first introduce a generalization of the Hermitean conjugate, transpose, Hermitean, skew-Hermitean, unitary, skew-unitary, projection, and exponential operators. We then pass to the isotopic generalization of the notion of determinant, trace, and eigenvalue of a linear operator. Some essential properties of this modular-isotopic formulation of the Hilbert space theory are identified. The results are then applied to Hadronic Mechanics. In particular, we present the hadronic generalization of a number of postulates of Atomic Mechanics, ranging from observables, states, and their time evolution, to total probability, its conservation in time, and the expectation values. We also prove that the isotopic generalization of Schroedinger's equations presented in Paper I are equivalent to the isotopic generalization of Heisenberg's equations.

30704 **Foundations of the hadronic generalization of the atomic mechanics. III. Bimodular-genotopic Hilbert space formulation of the interior strong problem.** Myung, H.C.; Santilli, R.M. (Inst. of Basic Research, Cambridge, MA). *Hadronic Journal;* 5: No. 4, 1367-1403(Jun 1982). (CONF-820136—). Contract AC02-80ER10651.

From 1. international conference on non-potential interactions and their Lie-admissible treatment; Orleans, France (5 Jan 1982).

This paper is devoted to a first formulation of the axiomatic Hilbert space foundations of the branch of the Hadronic Mechanics dealing with the interior strong non-Hamiltonian problem, that is, with the characterization of a particle under external unrestricted strong interactions, and which admits a Lie-admissible algebraic character. In particular, we are interested in extending the modular-isotopic generalization of the eigenvalue equations presented in the adjoining Paper II, into the broadest possible form permitted by a two-sided, bimodular (right and left) characterization of the Hilbert space. For this purpose we point out certain (yet unsolved) technical difficulties related to the preservation of the Hilbert space under a nonassociative algebra of operators. We then point out that these difficulties are absent when the theory is restricted to the original proposal by Santilli, the characterization of a hadron under extenal strong interactions via a birepresentation of a Lie-admissible algebra of operators on a bimodular Hilbert space in which each left and right action is associative-isotopic. In this way we achieve the Lie-admissible generalization of the contents of Paper II via the simple differentiation of the left and right isotopes, with products $AT(^+)B$ and $AT(^-)B$, where $T(^{+-})$ are fixed, generally different, bounded, and nonsingular operators. the Lie-isotopic modular formulations of Paper II result to be a particular case of the Lie-admissible bimodular formulations when $T(^+) = T(^-) = T$. The conventional atomic formulations result to be the simplest possible realization when $T(^+) = T(^-) = 1$.

30705 **Topological theory of electric charge.** Chew, G.F. (Lawrence Berkeley Lab., CA); Finkelstein, J.; McMurry, R.E. Jr.; Poenaru, V. *Physics Letters* [*Section*] *B;* 100: No. 1, 53-56(19 Mar 1981). Contract W-7405-ENG-48.

A recently-proposed topological theory of strong interactions is extended to electromagnetism. The values of the electric charges of both hadrons and leptons emerge naturally.

30706 **Jet production in diffractive dissociation of mesons and photons.** Randa, J. Boulder, CO; University of Colorado (1981). 9p. Contract AC02-76ER02114.

From 16. Recontre de Moriond; 21 Mar 1981 (Les Arcs, Savoie, France).

I consider the diffractive dissociation of photons and mesons into high-mass subsystems clearly separated in momentum space from fragments of the target proton. Such high-mass q anti q states should exhibit jet behavior. The mass and (decay) angle dependence of the mass section for production of these jets is predicted. The relative multiplicity of strange and charmed particles is also predicted and compared to that in e^+e^- jet production.

30707 **Can 35 pionic mass intervals among related resonances be accidental.** Mac Gregor, M.H. (Lawrence Livermore National Lab., CA (USA)). *Nuovo Cimento [Sezione] A;* **58**: No. 2, 159-192(21 Jul 1980).

Paper copy only, copy does not permit microfiche production7 refs.

By analogy with the situation that occurs in nuclear physics, one might expect to find the lowest-mass hadronic state - the pion - serving as a fundamental hadron building block. In line with this conjecture, and by a direct examination of the elementary-particle data 35 pionic mass intervals, π approximately -140 MeV, are observed among groups of related resonances. These pionic mass intervals, which occur in the narrow-width and S-state resonances, involve 50 elementary-particle states, or approximately 80% of the observed narrow-width states in the energy regions under examination. In particular, accurate pionic mass intervals are observed among the very-low-mass pseudoscalar mesons, the very-high-mass upsilon mesons, the intermediate-mass "charmonium" mesons, the "charmed" and uncharmed kaon states, the baryon and dibaryon excitations, and even the massive leptons. The accuracy and the universality of this result indicate, irrespective of theory, that the pion serves in some manner as a basic mass quantum in the generation (and the decay) of elementary-particle states, although this pionic excitation quantum does not follow the quantum number assignments that are ascribed to free pions.

6453 Particle Invariance Principles And Symmetries

REFER ALSO TO CITATION(S) 30665, 30718

30708 **(IC—79/46) Effect of scalar partons at short distances in unified theories with spontaneously broken colour symmetry.** Craigie, N.S.; Salam, A. (International Centre for Theoretical Physics, Trieste (Italy)). May 1979. 14p. NTIS (US Sales Only), PC A02/MF A01. Order Number DE83701484.

The effect of scalar partons arising in QCD if the colour symmetry is spontaneously broken is discussed. The authors use a previous result, which states that such scalars can be incorporated into the theory without disturbing asymptotic freedom.

6454 Field Theory

30709 **(ANL-HEP-CP—82-29) QCD diffraction: a critical phenomenon reflecting both confinement and chiral-symmetry breaking.** White, A.R. (Argonne National Lab., IL (USA)). Jul 1982. Contract W-31-109-ENG-38. 24p. (CONF-8206117—7). NTIS, PC A02/MF A01. Order Number DE83009519.

From 13. international symposium on multiparticle dynamics; Volendam, Netherlands (6 Jun 1982).

Arguments are presented for studying soft diffractive physics at anti p-p colliders in terms of Critical Pomeron Reggeon Field Theory. It is emphasized that both confinement and chiral-symmetry breaking play a vital role in the occurrence of the Critical Pomeron in QCD. SU(3) is the unique strong-interaction gauge group giving the Critical Pomeron and the maximum number of quarks allowed by asymptotic freedom is required for criticality.

30710 **(JINR—E-2-81-521) System of related massless dipole ghost fields in two space-time dimensions.** Mikhov, S.G. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1981. 12p. NTIS (US Sales Only), PC A02/MF A01. Order Number DE83701485.

A couple of massless dipole ghost fields in two space-time dimensions is studied. The latter fields are related by the condition that the underlying zero norm fields, that are present in the equations of the Froissart model, are in fact a couple of dual scalar and pseudoscalar fields. The commutation relations and the explicit operator solution are obtained. The infrared problem is discussed in some detail. The Lorentz transformations of the fields under which the whole problem is invariant are obtained, thus proving the consistency of the regularization procedure.

30711 **(JINR—E-2-81-798) Dynamics of generalized coherent states. Pt. 2. Classical equations of motion.** Nikolov, B.A.; Trifonov, D.A. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1981. 13p. NTIS (US Sales Only), PC A02/MF A01. Order Number DE83700188.

Using the Klauder approach the stable evolution of generalized coherent states (GCS) for some groups (SU(2), SU(1.1) and U(N)) is considered and it is shown that one and the same classical solution z(t) can correctly characterize the quantum evolution for many different (in general nonequivalent) systems. As examples some concrete systems are treated in greater detail: it is obtained that the nonstationary systems of the singular oscillator, of the particle motion in a magnetic field and of the oscillator with a friction all have stable SU(1.1) GCS whose quantum evolution is determined by one and the same classical function z(t). The physical properties of the constructed SU(1.1)GCS are discussed and it is shown particularly that in the case of discrete series Dsub(k)sup((+)) they are those states for which the quantum mean value coincides with the statistical one for an oscillator in a thermostat.

30712 **(JINR—R-2-81-665) Conformally invariant gauge fixing condition in quantum electrodynamics.** Stoyanov, D.Ts.; Sotkov, G.M. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1981. 11p. (In Russian). NTIS (US Sales Only), PC A02/MF A01. Order Number DE83700190.

A conformally invariant gauge fixing condition in the case of electromagnetic interaction is suggested. A conformally invariant quantization scheme for the Maxwell equation is formulated on the base of this condition. In the space of physical states arises a representation of the conformal group. A new method of quantization is illustrated by an example of a free electromagnetic field. The special conformally transformations for the vectors from the physical space are obtained in an explicit form.

30713 **(JINR—R-2-81-707) Vacuum energy in the Ysub(d) Yukawa model in the strong coupling limit.** Efimov, G.V.; Ivanov, M.A. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1981. 44p. (In Russian). NTIS (US Sales Only), PC A03/MF A01. Order Number DE83700191.

The Ysub(α) Yukawa model describing the pseudoscalar interaction of a fermion field PSI(x) and a boson field PHI(x) in the d-measured space-time Rsup(α) is considered. Density of interaction Lagrangian is written down in the form Lsub(I)(x)==. ig anti PSI(x)γ_5PSI(x)PHI(x), where γ_5 - Euclidean matrices. S matrix written down in the form of a functional integral in the Euclidean metrics is investigated. The Euclidean γ matrices and PSI, anti PSI spinors are determined in that way to provide covariance of relativity theory of Euclidean rotations and complete coincidence of S matrices in a series of perturbation theory in the suggested and standard approaches. Behaviour of vacuum energy density in the range of a strong coupling g $\rightarrow$ infinity has been obtained.

30714 **(JINR—R-2-82-26) Quantum symmetries in particle interactions.** Shirkov, D.V. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1982. 10p. (In Russian). NTIS (US Sales Only), PC A02/MF A01. Order Number DE83700194.

The concept of quantum symmetry is introduced. This is the symmetry which cannot be formulated without essential use of quantum ideas and notions. The role of three principles of quantum symmetry: renormalizability (or, probably, superrenormalizability) principle, local gauge symmetry principle, supersymmetry principle- in the development of quantum field theory is discussed. The conclusion is that these principles yield deterministic influence on the formation of modern theory of elementary interactions.

30715 **(KMU-HEP—82-05) Phase structure, magnetic monopoles and vortices in the lattice Abelian Higgs model.** Ranft, J.; Kripfganz, J.; Ranft, G. (Karl-Marx-Universitaet, Leipzig (German Democratic Republic). Sektion Physik). Apr 1982. 34p. NTIS (US Sales Only), PC A03/MF A01. Order Number DE83700195.

We present Monte Carlo calculations of lattice Abelian Higgs models in 4 dimensions and with charges of the Higgs particles equal to q = 1, 2 and 6. The phase transitions are studied in the plane of the two coupling constants considering separately average plaquette and average link expectation values. The density of topological excitations is studied. In the confinement phase we find finite densities of magnetic monopole currents, electric currents and vortex currents. The magnetic monopole currents vanish exponentially in the Coulomb phase. The density of electric currents and vortex currents is finite in the Coulomb phase and vanishes exponentially in the Higgs phase.

30716 **(KMU-HEP—82-06) Short-distance expansion of Wilson loops, gluon condensation and Monte Carlo lattice results.** Kirschner, R.; Kripfganz, J.; Ranft, J.; Schiller, A. (Karl-Marx-Universitaet, Leipzig (German Democratic Republic). Sektion Physik). Apr 1982. 21p. NTIS (US Sales Only), PC A02/MF A01. Order Number DE83700196.

The short-distance expansion of Wilson loops in terms of composite gluon operators (gluon condensate) is studied. The 2-loop perturbative contribution to Wilson loop ratios is evaluated. Monte-Carlo lattice results for SU(2) gluodynamics are analyzed in terms of this expansion. Consistent results for the gluon condensate are found.

30717 **(LYCEN—8164) Relativistic aspects of scalar fields (on some bases of wave mechanisms).** Louis, Gilbert. (Lyon-1 Univ., 69 - Villeurbanne (France). Inst. de Physique Nucleaire; Lyon-1 Univ., 69 (France)). 1981. 85p. (In French). NTIS (US Sales Only), PC A05/MF A01. Order Number DE83700197.

Thesis.

In this work, first we establish the general law of a scalar field transformation (in R or C) when we change of inertial frame, independently of any physical meaning associated to this field. Intuitively, if psi (r vector,t) is a field "seen" from the frame (R), we write the expression psi'(r'vector,t') which belong to the same field but "seen" from the frame (R') ((R) having the speed v vector in relation to (R')). For that, we use exclusively symmetry axioms of space-time-field. 1) In Galilean theory we find the law: psi'(r'vector,t') = psi (r vector,t) exp id(v vector r vector + 1/2 v^2t) with ral constant. Then, we show that Schroedinger equation, de Broglie formula lambda=h/p and the interpretation α=m/h are natural consequences of this law and of the least action principle. So in a strictly galilean framework we are led to a new vision of some basis of the quantum mechanics. We conclude on the epistemological interest of such a procedure by comparing it with some historical and conceptual aspects of special relativity and electromagnetism. 2) In Einsteinian theory we find the law: psi'(r'vector,t') = psi(r vector,t) exp idc [v vector/v.r vector shω+(chω-1)ct]. with ω=argtanh v/c. Then, a similar way to 1) led to an equivalent equation to Klein-Gordon's.

30718 **(SLAC-PUB—3053) Local supersymmetry and the problem of the mass scales.** Nilles, H.P. (Stanford Linear Accelerator Center, CA (USA); European Organization for Nuclear Research, Geneva (Switzerland)). Feb 1983. Contract AC03-76SF00515. 11p. (CONF-830139—1). NTIS, PC A02/MF A01. Order Number DE83008936.

From Workshop on problems in unification and supergravity; LaJolla, CA, USA (12 Jan 1983).

Spontaneously broken supergravity might help us to understand the puzzle of the mass scales in grand unified models. We describe the general mechanism and point out the remaining problems. Some new results on local supercolor are presented.

30719 **Lattice theory of quark confinement.** Rebbi, C. (Brookhaven National Lab., Upton, NY). *Scientific American;* **248**: No. 2, 54-65(Feb 1983).

The development of the Quark Model and the concept of quaark confinement are reviewed. Lattice Gauge Theory methods for approximating quantum chromodynamic calculations are described and Lattice Theory predictions for quark confinement are discussed. (KAW)

30720 **Dimensional reduction and flavor chirality.** Chapline, G. (California Univ., Livermore (USA). Lawrence Livermore National Lab.); Slansky, R. (Los Alamos National Lab., NM (USA). Theoretical Div.). *Nuclear Physics [Section] B;* **209**: No. 2, 461-483(27 Dec 1982).

We show that phenomenologically realistic flavor-chiral Yang-Mills-Higgs theories in 4 dimensions can be derived by dimensional reduction of 10-dimensional vectorlike and gauge theories, where the extra 6 dimensions form a compact coset space with scale size r. The dimensional reduction often implies a symmetry breaking pattern like that of the electroweak theory, in which case it is natural to propose r approx.= Gsub(F)sup(1/2). Quantum effects then determine the short-distance behavior of the theory, including any additional symmetry breaking.

30721 **Angular momentum paradoxes with solenoids and monopoles.** Lipkin, H.J. (Argonne National Lab., IL (USA); Fermi National Accelerator Lab., Batavia, IL (USA); Weizmann Inst. of Science, Rehovoth (Israel)); Peshkin, M. (Argonne National Lab., IL (USA)). *Physics Letters, [Section] B;* **118**: No. 4-6, 385-390(9 Dec 1982).

The Poynting vector produced by crossing the Coulomb field from a charged particle with a distant external magnetic field gives rise to a physical angular momentum which must be included in applications of angular momentum conservation and quantization. Simple examples show how the neglect of the return flux in an infinite solenoid or in two-dimensional models can lead to unphysical effects, how the Dirac charge quantization is obtained and can be modified by the presence of additional long range forces, and why the origin must be excluded in describing the motion of a point charge in the field of a fixed point monopole.

30722 **Plaquette formulation and the Bianchi identity for lattice gauge theories.** Batrouni, G.G. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). *Nuclear Physics [Section] B;* **208**: No. 3, 467-483(6 Dec 1982).

We extend Halpern's field-strength formulation and dual potentials (for continuum gauge theories) to abelian and non-abelian lattice gauge theories. New results include: (I) plaquette formulation of all lattice gauge theories, (II) the strong coupling expansion is seen as (a) a perturbation in dual links or (b) a gradual restoration of the lattice Bianchi identity. To leading order in the strong coupling expansion the lattice Bianchi identity is completely ignored. Geometrical interpretation of the lattice Bianchi identity is presented along with a discussion of the 'abelianization' of the non-abelian identity and its connection with gauge-invariant variables. For abelian theories we also show that the dual potential is Fourier conjugate to the Bianchi identity and that the Coulomb gas representation of these theories is easily obtained in this formulation.

30723 **Non-potential interaction and inseparable constituents of hadrons.** Sun, J. (Peking Univ., CHina). *Hadronic Journal;* **5**: No. 5, 1754-1763(Aug 1982). (CONF-820136—).

From 1. international conference on non-potential interactions and their Lie-admissible treatment; Orleans, France (5 Jan 1982).

The fundamental assumption on internal states of particles, as given in a joint paper, leads to the existence of nonpotential interaction between the non-particle constituents of hadrons. Such non-potential interaction causes the constituents of a hadron to be inseparable irrespective of the value and sign of energy. Thus, the constituents of a hadron can never be separated by bombardment, no matter how high the energy is; i.e. such a constituent can never appear as a particle. Such properties of constituents of hadrons come from their own essence, but not from any added requirement.

30724 **New approach to quantum field theory and a spacetime quantization.** Banai, M. (Central Research Inst. for Physics, Budapest, Hungary). *Hadronic Journal;* **5**: No. 5, 1812-1841(Aug 1982). (CONF-820136—).

From 1. international conference on non-potential interactions and their Lie-admissible treatment; Orleans, France (5 Jan 1982).

A quantum logical approach to achieve a sound kinematical picture for local quantum field theory is reviewed. A general language in the framework of axiomatic set theory is presented in which the local description can be formulated in almost the same form as quantum mechanics is formulated by von Neumann. The main physical implication of this approach is that quantization requires not only that of physical fields over M^4, but quantization of spacetime M^4 itself. A canonical quantization of M^4 can be implemented via the introduction of a spacetime quantum h, by imposing the commutation rules $[t, r] = ih$. Then, this rule implies $\Delta t\, \Delta r \geqq 1/2\ h$, i.e. a particle is not localizable better than 1/2 h. This uncertainty principle is compatible with Heisenberg's uncertainty principle, but it requires the generalization of Poincare symmetries to all unitary symmetries. Some indication shows that this approach might be successful in describing low lying hadronic phenomena. Santilli's original physical ideas whould partially be realized in this approach: the mutual overlaping of the wave functions of particles in short spacetime distances is (partially) taken into account by the introduction of h. Furthermore, locality loses its original meaning in the quantization of a RLFT. In this approach both the relativity and locality woudl become generalized in a RLQFT.

30725 **Unified theory of particle decay modes in electonic model.** Jian, C.X. *Hadronic Journal;* **5**: No. 4, 1517-1528(Jun 1982). (CONF-820136—).

From 1. international conference on non-potential interactions and their Lie-admissible treatment; Orleans, France (5 Jan 1982).

In a previous paper we have given a reasonable description of the total number of constituents (eletons and antieletons) in Santilli's structure model of hadrons. In this paper we shall extend these results to inlude decays of unstable hadrons. We shall continue to use the theory of stable and unstable groups with particular reference to Euler's function.

30726 **Gauge degrees of freedom of the LIE-admissible formulation of dynamical systems.** Trostel, R. (Institut fuer Theoretische Physik, Berlin, Germany). *Hadronic Journal;* **5**: No. 4, 1529-1545(Jun 1982). (CONF-820136—).

From 1. international conference on non-potential interactions and their Lie-admissible treatment; Orleans, France (5 Jan 1982).

We consider the classical motion of an eleton in viscous hadronic matter under variationally nonselfadjoint forces supposed to be of at most first differential type. By using Santilli's construction of the Lie-admissible algebra associated with the eletonic dynamics, we have found an isotopic degree of freedom induced by the set of gauge transformations originated by the ambiguity of the splitting of the forces into their selfadjoint and nonselfadjoint parts. Therefore, we obtain an equivalence class of Lie-admissible algebras acting on the functions of the phase space enlarged by time. All its representants differ by variationally selfadjoint forces incorporated into the nonselfadjoint force which is the crucial ingredient for constructing Santilli's matrix and from this the Lie-admissible algebra. Taking one representant whose selfadjoint force has been added to the nonselfadjoint force, means that one has tranformed the whole electro-dynamical force into the hadronic interaction force which seems philosophically reasonable. By dealing with systems whose nonselfadjoint forces vanish identically, we also obtain an equivalence class of Lie-admissible algebras incorporating a certain part of the given selfadjoint force ito Santilli's matrix. Evidently, there is one representant of this class of Lie-admissible algebras which is identical Lie itself. Taking other representants of this equivalence class would give us new examples of Lie-admissible algebras already at the conventional electrodynamical level.

65 PHYSICS RESEARCH

6510 Nuclear Physics

30727 **(AECL—7328) Progress report, Physics Division, 1 January - 31 March 1981.** (Atomic Energy of Canada Ltd., Chalk River, Ontario. Chalk River Nuclear Labs.). May 1981. 125p. (PR-P—129). NTIS (US Sales Only), PC A06/MF A01. Order Number DE83700425.

The nuclear physics group used the on-line isotope separator to make direct mass doublet measurments for the first time and to identify a new α-emitter, hafnium-162. A new NaI(Tl) detector gave improved data on the multiplicities and intensities of continuum γ-rays in gadolinium-147. Beam profile data for the Fast Intense Neutron source showed that tritium loss from bombarded targets is not caused by beam hot-spots. Geometry studies on the High Current Proton Accelerator showed that proton fraction increases with improved arc and gas efficiencies. In conjunction with fertile-to-fissile conversion experiments at TRIUMF, two types of monitoring foils agreed within 2.5% with results obtained by two other laboratories. Neutron diffraction data for a single β-N_2 crystal at 0.4 MPa showed that its scattering density distribution and mean translation displacements have almost perfect spherical symmetry. A new non-linear stress analysis code was marketed.

30728 **(CONF-801299—) Nuclear physics and solid-state physics symposium. Volume 23B. Nuclear physics.** (Department of Atomic Energy, Bombay (India)). 1980. 367p. NTIS (US Sales Only), PC A16. Order Number DE82904742.

From Symposium on nuclear physics and solid state physics; New Delhi, India (11 Dec 1980).

Paper copy only, copy does not permit microfiche production.

Separate entries were made in the data base for the 142 papers presented. (WHK)

30729 **(INS-R—271) Nuclear Physics Group progress report July-December 1979.** McCallum, G.J. (ed.). (Department of Scientific and Industrial Research, Lower Hutt (New Zealand). Inst. of Nuclear Sciences). Feb 1980. 34p. NTIS (US Sales Only), PC A03/MF A01. Order Number DE83700430.

The work of the Nuclear Physics Group of the Institute of Nuclear Sciences for the period July-December 1979 is described.

30730 **(INS-R—277) Nuclear Physics Group progress report January-June 1980.** McCallum, G.J. (ed.). (Department of Scientific and Industrial Research, Lower Hutt (New Zealand). Inst. of Nuclear Sciences). Aug 1980. 29p. NTIS (US Sales Only), PC A03/MF A01. Order Number DE83700431.

The work of the Nuclear Physics Group of the Institute of Nuclear Sciences for the period January - June 1980 is described.

30731 **(MPI-H—1982-V-20) Proceedings of the international conference on hypernuclear and kaon physics.** Povh, B. (Max-Planck-Institut fuer Kernphysik, Heidelberg (Germany, F.R.)). 1982. 422p. Available from Fachinformationszentrum Energie, Physik, Mathematik, Karlsruhe (Germany, F.R.).

From International conference on hypernuclear and kaon physics; Heidelberg (Germany, F.R.) (20 - 25 Jun 1982).

These proceedings contain the articles presented at the named conference. These concern Λ and Σ hypernuclei, spin-orbit coupling, kaon-nucleon interactions, baryon-baryon interactions, exotic atoms, kaon production, the production of hypernuclei, and kaon facilities. Separated abstracts were prepared for the articles in these proceedings.

6511 Experimental Techniques

REFER ALSO TO CITATION(S) 30740

30732 (ANL—83-4, pp 162-178) **Absorption and activation techniques in measurements of fast-neutron capture cross sections.** Bergqvist, I. (Univ. of Lund, Sweden). 1982. NTIS, PC A99/MF A01.

From NEANDC/NEACRP specialists meeting on fast-neutron capture cross sections; Argonne, IL, USA (20 Apr 1982).

The absorption and activation methods have been applied for a long time to systematic studies of fast neutron capture cross sections. Both methods are simple in principle but difficult in practice. The simplicity should ensure a wider use of the methods in particular for problems which may be complicated to approach with other methods. The difficulties encountered in absorption measurements are related to multiple scattering and resonance shielding effects. In activation experiments the influence of secondary low-energy neutrons causes the main problems.

30733 (ANL—83-4, pp 205-238) **Prompt gamma-ray detectors for the measurement of neutron capture cross-sections.** Gayther, D.B.; Thom, R.B. (Atomic Energy Research Establishment, Harwell, England). 1982. NTIS, PC A99/MF A01.

From NEANDC/NEACRP specialists meeting on fast-neutron capture cross sections; Argonne, IL, USA (20 Apr 1982).

A review is given of current techniques for detecting prompt gamma-radiation as a means of measuring total capture cross-sections. The discussion is generally restricted to systems with low or moderate gamma-ray energy resolution. Three classes of detector are considered: (1) the total absorption type; (2) detectors with efficiency proportional to gamma-ray energy; and (3) detectors of low efficiency and known gamma-ray response. Particular attention is given to the problems of background from reactions which compete with neutron capture, and the sensitivity of capture detectors to scattered neutrons. The extraction of capture yields from observed data is briefly considered.

30734 (ANL—83-4, pp 255-261) **Fast neutron capture cross section measurement with pulse-height weighting technique.** Yamamuro, N.; Igashira, M.; Shimizu, M. (Tokyo Inst. of Tech., JApan). 1982. NTIS, PC A99/MF A01.

From NEANDC/NEACRP specialists meeting on fast-neutron capture cross sections; Argonne, IL, USA (20 Apr 1982).

Neutron capture cross section measurement has been performed in the energy range from 200 to 610 keV with the pulse-height weighting technique. Monoenergetic neutrons were generated by ^{7}Li(p,n) reaction, and capture gamma-rays emitted from a sample were detected with a hollow cylindrical NE-213 scintillation detector. The volume of the scintillator is about 10 liter. An annular graphite gamma-ray absorber was inserted into the center of the detector as to make the weighting function straight as possible. To reduce te background, a cube of 40-cm boric-acid and paraffin surrounded the neutron source, and a hollow cylindrical shield consisting of 10-cm thick lead and 35-cm thick boric-acid and paraffin surrounded the detector. The capture cross sections of ^{165}Ho at the neutron energies of 200, 300, 460, and 610 KeV were obtained from the relative values to the ^{197}Au(n,γ) cross sections which were quoted from the ENDF/B-V file. The uncertainty of the data was 8 ~ 10%.

6512 Nuclear Properties And Reactions, A=1-5

REFER ALSO TO CITATION(S) 30664, 30779

30735 **(IPNO-PhN—81-07) Study of the ^{3}He(p,π^{+})^{4}He reaction close to threshold.** Willis, N.; Bimbot, L.; Le Bornec, Y.; Reide, F.; Willis, A.; Koori, N.; Wilkin, C. (Paris-11 Univ., 91 - Orsay (France). Inst. de Physique Nucleaire). 1981. 11p. NTIS (US Sales Only), PC A02/MF A01. Order Number DE83701490.

The ^{3}He(p,π^{+})^{4}He reaction has been measured at three different energies close to threshold. The laboratory angular range covered varies between 20 deg and 110 deg at 201 MeV, 20 deg and 70 deg at 190 MeV AND 20 deg and 40 deg at 180 MeV. The forward cross sections are of the order of a few μb/sr.

6513 Nuclear Properties And Reactions, A=6-19

30736 **(CONF-830138—1) Orbiting in collisions between light heavy ions (A/sub T/ + A/sub P/ < 50).** Shapira, D.; Erb, K.A.; Ford, J.L.C. Jr.; Gomez del Campo, J.; Shivakumar, B.; Novotny, R.; Schuell, D.; Thornton, S.T.; Parks, R.L.; Cecil, R. (Oak Ridge National Lab., TN (USA); Virginia Univ., Charlottesville (USA). Dept. of Physics). 1983. Contract W-7405-ENG-26. 29p. NTIS, PC A03/MF A01. Order Number DE83009794.

From Symposium on nuclear physics; Oaxtepec, Mexico (4 Jan 1983).

Portions are illegible in microfiche products.

Evidence is presented for the formation of a long-lived rotating dinuclear complex in the early stages of the collision between light heavy nuclei. A study of the variation of the total kinetic energy of the outgoing fragments with bombarding energy allows a determination of the average dinuclear separation prior to scission. At higher bombarding energies the study reveals that the system of the two colliding nuclei has reached a critical value of angular momentum beyond which it can not be trapped into an orbiting configuration.

30737 **(JINR—E-1-81-623) Inelastic interactions of p, d, ^{4}He and ^{12}C projectiles with light (CNO) and heavy (AgBr) nuclei at 4.5 GeV/c per nucleon.** Abdelsalam, A. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of High Energy). 1981. 11p. NTIS (US Sales Only), PC A02/MF A01. Order Number DE83701535.

The inelastic interactions of p, d, He^{4} and C^{12} with emulsion nuclei at 4.5 GeV/c per nucleon have been studied. A statistical method is offered to separate interactions with light (CNO) and heavy (AgBr) nuclei. In this case the integral distribution of the number particles from disintegration of target is used. The distributions of multiparticle production have been studied, and it has been found that a general relation for the dispersion as a function of multiplicity <nsub(s)> is D=(0.59+-0.03)<nsub(s)>-(0.03+-0.01) for different projectiles. The pseudorapidity distribution for p and C^{12} has been studied. It is shown that the number of emitted particles in the target fragmentation region is related to the number of interacting nucleons from the projectile nucleus.

30738 **Energy dependence of pion-induced isotensor double charge exchange.** Bland, L.C. (Pennsylvania Univ., Philadelphia (USA)); Fortune, H.T. (Los Alamos National Lab., NM (USA); Pennsylvania Univ., Philadelphia (USA)); Greene, S.J. (New Mexico State Univ., Las Cruces (USA)); Moore, C.F. (Texas Univ., Austin (USA)); Morris, C.L. (Los Alamos National Lab., NM (USA)). *Journal of Physics G: Nuclear Physics;* 8: No. 11, L173-L177(Nov 1982).

Data for ^{16}O(π^{+},π^{-})^{16}Ne at a laboratory angle of 5° as a function of energy are well fitted with a Breit-Wigner resonance at 169 +- 4 MeV, with a width of 66 +- 6 MeV. The same curve gives an acceptable fit to data for ^{24}Mg. The energy-dependent phase extracted from an earlier two-amplitude model of double charge exchange is consistent with these resonance parameters.

6514 Nuclear Properties And Reactions, A=20-38

REFER ALSO TO CITATION(S) 30738, 30741

30739 **(ANU-P—819) Quadrupole moment of ^{26}Mg as a test of shell-model interactions.** Spear, R.H.; Zabel, T.H.; Esat, E.T.; Baxter, A.M.; Hinds, S. (Australian National Univ., Canberra. Dept. of Nuclear Physics). Jan 1982. 13p. NTIS (US Sales Only), PC A02/MF A01. Order Number DE83701511.

The static quadrupole moment and the B(E2; $0_1^{+}\rightarrow 2_1^{+}$) value of the first excited state of ^{26}Mg have been measured using the reorientation effect in Coulomb excitation of ^{26}Mg projectiles. It is found that the static quadrupole moment is -13.6 +- 3.0(-9.5 +- 3.0) e fm^{2} and B(E2; $0_1^{+}\rightarrow 2_1^{+}$) = 322 +- 16(328 +- 16)e^{2} fm^{4} for constructive (destructive) interference from higher states: The result for the static quadrupole moment clearly differentiates among

several alternative effective interactions which have been used in shell-model calculations.

6515 Nuclear Properties And Reactions, A=39-58

30740 (ANL—83-4, pp 394-416) **Status of structural material data in the resolved resonance region.** Rohr, G. (CEC-JRC, Geel, Belgium). 1982. NTIS, PC A99/MF A01.

From NEANDC/NEACRP specialists meeting on fast-neutron capture cross sections; Argonne, IL, USA (20 Apr 1982).

This review is mainly concerned with the accuracy aspect of neutron capture data for structural materials. As examples data sets of ^{54}Fe, ^{56}Fe and ^{57}Fe will be compared critically. The results of the investigation of the C_6D_6 detector performed at CBNM will be used to study the deviations in the different data sets. Recommendations to reduce the uncertainty of capture data and to improve the capture detectors using the weighting method will be given.

30741 (ANL—83-4, pp 417-430) **Neutron capture widths of s-wave resonances in ^{56}Fe, ^{58} ^{60}Ni and ^{27}Al.** Wisshak, K.; Kaeppeler, F.; Reffo, G.; Fabbri, F. (Kernforschungszentrum, Karlsruhe, Germany). 1982. NTIS, PC A99/MF A01.

From NEANDC/NEACRP specialists meeting on fast-neutron capture cross sections; Argonne, IL, USA (20 Apr 1982).

The neutron capture widths of s-wave resonances in ^{56}Fe (27.7 keV), ^{58}Ni (15.4 keV), ^{60}Ni (12.5 keV) and ^{27}Al (35.3 keV) have been determined, using a setup completely different from LINAC experiments. A pulsed 3 MV Van de Graaff accelerator and the ^{7}Li(p,n) reaction served as a neutron source. The proton energy was adjusted just above the reaction threshold to obtain a kinematically collimated neutron beam. This allowed to position the samples at a flight path as short as ~ 90 mm. Capture events were detected by three Moxon-Rae detectors with graphite, bismuth-graphite and pure bismuth converter, respectively. The measurements were performed relative to a gold standard. The setup allows to discriminate capture of scattered neutrons completely by time of flight and to use very thin samples (0.15 mm) in order to reduce multiple scattering. After correction for deviations of the detector efficiency from a linear increase with gamma-ray energy, the results obtained with different detectors agree within their remaining systematic uncertainty of ~ 5%. Only preliminary results are presented.

30742 (ANL—83-4, pp 431-436) **Evaluation of the radiation width of the 27.7 keV resonance in ^{56}Fe.** Allen, B.J. (AAEC Research Establishment, Sutherland, Australia). 1982. NTIS, PC A99/MF A01.

From NEANDC/NEACRP specialists meeting on fast-neutron capture cross sections; Argonne, IL, USA (20 Apr 1982).

A critical review is given of measurements of the radiation width of the 27.7 keV resonance in ^{56}Fe. An evaluation of results yields a recommended value of $\Gamma\ \gamma$ + 1.00 +- 0.04 eV for this resonance.

30743 (ANL—83-4, pp 564-569) **Fast-neutron capture in structural materials.** Froehner, F.H. (Kernforschungszentrum, Karlsruhe, Germany). 1982. NTIS, PC A99/MF A01.

From NEANDC/NEACRP specialists meeting on fast-neutron capture cross sections; Argonne, IL, USA (20 Apr 1982).

The discussions of developments in the field of capture data of structural materials since the 1977 Geel meeting were mainly based on the invited paper presented by G. Rohr and on information from the other participants about their own activities. There was not much input about recent work in japan, where the new version JENDL-2 of the Japanese Evaluated Nuclear Data Library has been issued, or on the resonance analysis work on iron and nickel isotopes going on at ORNL. Moreover, the discussion was restricted to the three principal structural material elements Cr, Fe and Ni. Some of the remaining structural materials such as Zr and Mo were covered by the Working Group on Fission Product Nuclides.

30744 **(IPNO-PhN—81-11) Two-step processes in the ^{40}Ca(α,^{3}He)^{41}Ca reaction.** Fortier, S.; Maison, J.M.; Picot, P.; Gales, S.; Hourani, E.; Schapira, J.P. (Paris-11 Univ., 91 - Orsay (France). Inst. de Physique Nucleaire). 1981. 23p. NTIS (US Sales Only), PC A02/MF A01. Order Number DE83701527.

The ^{40}Ca(α, ^{3}He) reaction has been studied at 36 MeV incident energy. About fifty levels have been observed up to 7.1 MeV excitation energy and angular distributions were measured from 6 deg to 60 deg, using a split-pole spectrometer. A local zero-range DWBA analysis has been carried out, and the deduced l-assignments and spectroscopic factors are compared with those obtained from previous neutron stripping experiments. Core-excited states in ^{41}Ca with a[3$^-$, f7/2], [2$^+$, f7/2] and [5$^-$, f7/2] component previously observed in inelastic scattering experiments, are selectively excited by the (α, ^{3}He) reaction. Their angular distributions are compared with coupled-reaction-channel calculations, assuming a pure two-step reaction mechanism. The agreement between theory and experiment may be considered as rather satisfactory for a number of levels. In particular the $1/2^+$ and $3/2^+$ levels and the high spin states with Jsup(π)=$9/2^-$, $11/2^+$, $15/2^+$ and $17/2^+$ are successfully described within the framework of the weak-coupling model.

6516 Nuclear Properties And Reactions, A=59-89

REFER ALSO TO CITATION(S) 30741

6517 Nuclear Properties And Reactions, A=90-149

REFER ALSO TO CITATION(S) 30732, 30736, 30737, 30740

30745 (ANL—82-80, pp 571-581) **Cascade neutron yields from energetic heavy ion interactions.** Barbier, M.M. (Marcel M. Barbier, Inc., Herndon, VA). Jan 1983. NTIS, PC A99/MF A01.

From 6. annual international collaboration of advanced neutron sources meeting; Argonne, IL, USA (28 Jun 1982).

Experimental data on heavy ion production of cascade neutrons (neutron energy above 20 MeV) is collected and reviewed. Cascade neutron production figures per unit solid angle are given as a function of emission angle for projectiles up to Ar 40 and incident energies up to 2100 MeV/AMU. Total cascade neutron yields per event are derived and found not to increase when going to heavier projectiles.

30746 **(ANL—83-4) Fast-neutron capture cross sections.** Smith, A.B.; Poenitz, W.P. (eds.). (Argonne National Lab., IL (USA); Organization for Economic Co-Operation and Development, 75 - Paris (France)). 1982. Contract W-31-109-ENG-38. 603p. (NEANDC(US)—214/L; CONF-820438—). NTIS, PC A99/MF A01. Order Number DE83008920.

From NEANDC/NEACRP specialists meeting on fast-neutron capture cross sections; Argonne, IL, USA (20 Apr 1982).

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SEparate abstracts were prepared for 30 of the 39 papers presented. Nine papers wre previously included in the data base. (WHK)

30747 (ANL—83-4, pp 63-66) **El gamma strength from (γ,n) measurement in ^{95}Mo.** Coceva, C.; Magnani, M.; Stefanon, M. (ENEA, Bologna, Italy). 1982. NTIS, PC A99/MF A01.

From NEANDC/NEACRP specialists meeting on fast-neutron capture cross sections; Argonne, IL, USA (20 Apr 1982).

Threshold photoneutron measurements of the reaction ^{95}Mo(γ,n$_0$) were carried out in the neutron-energy interval 50 to 300 keV. Gamma-rays were obtained by bremsstrahlung of electrons accelerated by a low-energy linac; neutron energy was measured by time-of-flight. The cross-section is obtained by calibration with known ^{208}Pb(γ,n) resonances. An estimate of the electric dipole average gamma strength is deduced.

30748 (ANL—83-4, pp 133-143) **Total γ-ray spectra and isomeric ratio calculations in fast neutron radiative capture.** Reffo, G. (ENEA, Bologna, Italy). 1982. NTIS, PC A99/MF A01.

From NEANDC/NEACRP specialists meeting on fast-neutron capture cross sections; Argonne, IL, USA (20 Apr 1982).

Estimates of total γ-ray spectra and isomeric ratios have been attempted in the framework of the optical and statistical models for neutron radiative capture. The role of optical model, of Brink-Axel and Weisskopf assumptions as well as of the most important parameters have been investigated. The results of these calculations satisfactorily agree with experimental information in all cases considered. Spectra calculations were used in relative neutron capture measurements for correction of systematic uncertainties due to non-linear efficiency of the Moxon-Rae detector. Data on the calculated total γ-ray spectra and the corresponding integrated cross sections are shown for the isotopes investigated. The impact of parameters involved is discussed.

30749 (ANL—83-4, pp 179-185) **Absolute measurements of the fast neutron capture cross section of ^{115}In.** Grady, D.J.; Knoll, G.F.; Robertson, J.C. (Univ. of Michigan, Ann Arbor). 1982. NTIS, PC A99/MF A01.

From NEANDC/NEACRP specialists meeting on fast-neutron capture cross sections; Argonne, IL, USA (20 Apr 1982).

The ^{115}In(n,γ)/sup 116m1/In cross section has been absolutely determined at neutron energies of 23, 265 and 964 keV. These energies are the median neutron energies of the three photoneutron sources. Sb-Be, Na-CD_2 and Na-Be, utilized in this work. The measurements are independent of other cross section data except for corrections amounting to less than 10%. Independent determinations of the reaction rate, detector efficiency, neutron source strength, scalar flux and target masses were performed. Reaction rates were determined by beta counting of the /sup 116ml/In decay activity using a 4π gas flow proportional counter. Detector efficiency was measured using 4π β-γ coincidence counting techniques and the foil absorber method of efficiency extrapolation for correction of complex decay scheme effects. Photoneutron source emission rates were determined by intercomparison with the NBS-II calibrated ^{252}Cf spontaneous fission neutron source in the University of Michigan Manganese Bath. The normalized scalar flux was calculated from the neutron emission angular distribution results of the Monte Carlo computer program used to model neutron and gamma transport in the source. Target mass determinations were made with a microbalance. Correction factors were applied for competing reaction activities, neutron scattering from experiment components, room-return induced activities, spectral effects in the manganese bath and the neutron energy spectra of the photoneutron sources. Experimental cross section results were normalized to the source median energy using energy spectra d cross section shape data. The absolute cross sections obtained for the ^{115}In(n,γ)/sup 116ml/In reaction were 588 +- 12, 196 +- 4 and 200 +- 3 millibarns at 23, 265 and 964 keV, respectively.

30750 (ANL—83-4, pp 186-195) **Measurements and model calculations of the ^{110}Cd(n,γ)/sup 111m/Cd cross section.** Smith, D.L.; Meadows, J.W.; Moldauer, P.A.; Poenitz, W.P. (Argonne National Lab., IL). 1982. NTIS, PC A99/MF A01.

From NEANDC/NEACRP specialists meeting on fast-neutron capture cross sections; Argonne, IL, USA (20 Apr 1982).

The cross section for the ^{110}Cd(n,γ)/sup ^{111}m/Cd reaction has been measured in the energy 0.14 to 1.5 MeV by means of activation. Both natural cadmium and ^{110}Cd- and ^{111}Cd-enriched samples were used in the measurements in order to distinguish the capture activation reaction from the ^{111}Cd(n,n')/sup 111m/Cd reaction, which becomes involved due to the presence of ^{111}Cd in the samples. Optical, statistical and gamma-ray cascade model calculations were performed in order to explain the energy dependence of the capture activation cross section.

30751 (ANL—83-4, pp 196-204) **Neutron-capture-activation cross sections of $^{94\ 96}$Zr and $^{98\ 100}$Mo at thermal and 30 keV energy.** Wyrick, J.M.; Poenitz, W.P. (Argonne National Lab., IL). 1982. NTIS, PC A99/MF A01.

From NEANDC/NEACRP specialists meeting on fast-neutron capture cross sections; Argonne, IL, USA (20 Apr 1982).

Neutron-capture cross sections of $^{94\ 96}$Zr and $^{98\ 100}$Mo were measured relative to the standard-capture cross section of gold at thermal and 30 keV neutron energies using the activation technique. The reported values are based upon available decay-scheme information.

30752 (ANL—83-4, pp 239-247) **Fast-neutron capture-cross-section measurements with the Argonne National Laboratory large-liquid-scintillator tank.** Poenitz, W.P. (Argonne National Lab., IL). 1982. NTIS, PC A99/MF A01.

From NEANDC/NEACRP specialists meeting on fast-neutron capture cross sections; Argonne, IL, USA (20 Apr 1982).

Measurements of the neutron-radioactive-capture cross sections of Y, Zr, Mo, Ag, Cd, In, Sb, La, Eu, Gd, Tb, Dy, Er, Yb, Hf, W, Re, and Pt in the 0.5 to 4.0-MeV-energy range are presented. A large-liquid-scintillator detector was used for detecting the capture events. A grey neutron detector was used as neutron monitor. The reported cross sections are relative to the capture cross section of gold at 0.5 MeV. Where prior data exist the present data are lower for most elements. However, good agreement was obtained with very recent results reported by the group from Bruyeres-le-Chatel.

30753 (ANL—83-4, pp 262-274) **Gamma-rays from radiative capture reactions in ^{133}Cs, ^{181}Ta and ^{197}Au.** Yamamuro, N. (Tokyo Inst. of Tech., Japan); Igashira, M.; Shirayanagi, H.; Fujita, Y.; Kobayashi, K. 1982. NTIS, PC A99/MF A01.

From NEANDC/NEACRP specialists meeting on fast-neutron capture cross sections; Argonne, IL, USA (20 Apr 1982).

Gamma-ray spectra following neutron capture in ^{133}Cs, ^{181}Ta and ^{197}Au have been measured at the neutron energy from 1.5 to 75 keV using linac-TOF method. A sample was located at 12 m from the neutron source, and a pair of deuterated benzen (C_6D_6) liquiid scintillation detectors with 11 cm diam by 5 cm thick was set at the both sides of sample. Response functions of the detector were calculated by a Monte-Carlo method, and the energy resolution of the detector was determined by comparing the calculated energy deposit spectra with the measured spectra. To unfold the gamma-ray spectrum from the observed one, a 93 x 256 gamma-ray response matrix was generated by interpolation from the response functions. The capture gamma-ray spectra for cesium, tantalum and gold were obtained by means of the unfolding code FERDOR. The spectra in gold and cesium show the 5.5 MeV anomaly, as expected from other experiments. The gamma-ray strength functions were calculated by the spectrum-fitting method. As the result of this calculation in gold, it was found that the better spectrum fitting was obtained if the two pigmy resonances were assumed to exist at 5 MeV and 6 MeV.

30754 (ANL—83-4, pp 437-463) **Differential fission product capture cross section measurements since Bologna.** Block, R.C. (Rensselaer Polytechnic Inst., Troy, NY). 1982. NTIS, PC A99/MF A01.

From NEANDC/NEACRP specialists meeting on fast-neutron capture cross sections; Argonne, IL, USA (20 Apr 1982).

Differential capture cross section measurements of fission products are reviewed for the time period since the 1979 Bologna Specialist's Meeting on Neutron Cross Sections of Fission Products. Fission product capture data from nine laboratories in seven countries have been reported, and these results are discussed in regard to fast reactor applications.

30755 (ANL—83-4, pp 464-472) **Average capture cross section of the fission product nuclei ^{105}Pd and ^{108}Pd.** Rohr, G.; Bastian, C.; Cornelis, E.; Shelley, R.; van der Veen, T.; Vanpraet, G. (CEC-JRC, Geel, Belgium). 1982. NTIS, PC A99/MF A01.

From NEANDC/NEACRP specialists meeting on fast-neutron capture cross sections; Argonne, IL, USA (20 Apr 1982).

Neutron capture cross section measurements on enriched stable isotopes have been performed at the 30 m station of Gelina in the energy range of 10 eV up to 600 keV. The neutron flux shape was determined with a 0.5 mm ^{6}Li-glass scintillator and a 0.6 mm thick $^{10}B_4C$-slab. The time dependent background was evaluated by using the yields from a 0.5 mm ^{208}Pb capture sample. The present

data analysis covers the energy range between 10 keV and 300 keV.

30756 (ANL—83-4, pp 473-517) **Status of recent fast capture cross section evaluations for important fission product nuclides.** Gruppelaar, H. (Netherlands Energy Research Foundation, Petten). 1982. NTIS, PC A99/MF A01.

From NEANDC/NEACRP specialists meeting on fast-neutron capture cross sections; Argonne, IL, USA (20 Apr 1982).

A comparison is made between recent evaluations of fission-product cross sections as given in the CNEN/CEA, ENDF/B-IV, ENDF/V-V, JENDL-1, RCN-2 and RCN-3 data libraries. The intercomparison is restricted to 24 important fission products in a fast power reactor. The evaluation methods used to obtain the various data files are reviewed and possible shortcomings are indicated. A survey is given of the experimental data based used in the various evaluations. Some graphs are included showing the new ENDF/B-V and RCN-3 fastcapture cross-section evaluations. Further intercomparisons are made by means of multi-group and one-group cross sections. It is shown that lumped fission-product cross sections calculated from the most recent versions of the data files are in quite good agreement with each other. This review concludes with a discussion on observed discrepancies and requests for new measurements. 78 references.

30757 (ANL—83-4, pp 570-585) **Fast-neutron capture cross sections for the most important fission-product nuclei.** Gruppelaar, H. 1982. NTIS, PC A99/MF A01.

From NEANDC/NEACRP specialists meeting on fast-neutron capture cross sections; Argonne, IL, USA (20 Apr 1982).

The main activity of the fission-product (FP) Working Group was the discussion of the current status of neutron capture knowledge of the most important FP nuclides, including the formulation of recommendations toward improved understanding. The results of the discussion are summarized. General conclusions and recommendations are given. The status of integral data is summarized by R. Anderl; and nuclear models and calculations are reviewed by D. Gardner and G. Reffo.

30758 (ANL—83-4, pp 586-589) **Some summary reflections.** Smith, A.B. (Argonne National Lab., IL). 1982. NTIS, PC A99/MF A01.

From NEANDC/NEACRP specialists meeting on fast-neutron capture cross sections; Argonne, IL, USA (20 Apr 1982).

A brief review of some of the topics discussed at the conference are given in this concluding speech for the conference. (WHK)

30759 (DOE/ER/10418—T3) **Light particle and gamma ray emission measurements in heavy ion reactions. Progress report.** Petitt, G.A. (Georgia State Univ., Atlanta (USA). Dept. of Physics and Astronomy). 1983. Contract AS05-79ER10418. 16p. NTIS, PC A02/MF A01. Order Number DE83010127.

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Studies of neutron and charged particle emission in heavy ion reactions using the facilities at the HHIRF and the new computer facilities at Georgia State are briefly described. A progress report for 1982 to 1983 is combined with a proposal for work to be performed during 1983 to 1984. Present activities and immediate plans for a run already approved by the Program Advisory Committee of the HHIRF are discussed. (WHK)

30760 (LUIP—8205) **Disintegration of Nuclei in Violent Heavy Ion Interactions at 55A MeV - 110A MeV.** Jakobsson, B.; Joensson, G.; Lindkvist, B; Oskarsson, A. (Lund Univ. (Sweden). Fysiska Institutionen). May 1982. 45p. (LUNFD6/NFFK—7018/1-31(1982)). NTIS (US Sales Only), PC A03/MF A01. Order Number DE83700201.

High multiplicity ^{12}C induced reactions in Ag(Br) at energies between 55A MeV and 110A MeV have been selected and investigated event by event in nuclear emulsions. Only a fraction of these events can possibly be described in terms of a normal thermal spectator- participant mechanism. Several events exhibit a violent breakup into several light and medium-mass fragments. A strong suppression of projectile associated proton- and composite particle emission in the forward direction is found in comparison with inclusive spectra. A large part of the low energy protons originates from a very slow source, with a velocity comparable to that of the heaviest fragment. The parallel fraction of the c.m. energy in each event, which is governed by the more energetic protons, has a broad distribution with a mean value of 0.61 and thus with no signals of collective production mechanisms.

30761 **IBA calculations near the Z=64 subshell.** Gill, R.L.; Casten, R.F.; Warner, D.D. (Brookhaven National Lab., Upton, NY (USA). Physics Dept.); Brenner, D.S. (Clark Univ., Worcester, MA (USA). Dept. of Chemistry); Walters, W.B. (Maryland Univ., College Park (USA). Dept. of Chemistry). *Physics Letters, [Section] B;* **118**: No. 4-6, 251-255(9 Dec 1982).

It has recently been shown that the effects of the Z = 64 subshell are important for nuclides with N <= 88 but disappear as N approaches 90, due to the influence of neutron-proton interactions. IBA-2 calculations show excellent agreement with experimental energy systematics if the effective reduction in valence bosons caused by the Z = 64 subshell closure is explicitly included. The deduced parameters then behave as predicted by the microscopic basis of the IBA-2 model, in contrast with previous studies.

30762 **Nuclear structure and heavy-ion fusion.** Stokstad, R.G. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). *Nukleonika;* **26**: No. 3, 373-424(1981).

From 13. Summer school in nuclear physics; Mikolajki (Poland) (1 - 13 Sep 1980).

95 refs.

A series of lectures is presented on experimental studies of heavy-ion fusion reactions with emphasis on the role of nuclear structure in the fusion mechanism. The experiments considered are of three types. The fusion of lighter heavy ions (A<=20) at subcoulomb energies is studied with in-beam γ-ray techniques, the subbarrier fusion of ^{16}O and ^{40}Ar with the isotopes of samarium is detected out of beam by x-radiation from delayed activity, and measurements at very high energies, again for the lighter ions, employ direct particle identification of evaporation residues. The experimental data are compared with predictions based on the fusion of two spheres with the only degree of freedom being the separation of the centers, and which interact via potentials which vary smoothly with changes in the mass and charge of the projectile and target. The data exhibit large deviations from the systematic predictions.

6518 Nuclear Properties And Reactions, A=150-189

REFER ALSO TO CITATION(S) 30734, 30752, 30753, 30762

30763 **Level scheme of ^{160}Yb and the predicted SU(3)-O(6) transition in the N=90 isotones.** Garrett, C.; Rastikerdar, S.; Gelletly, W. (Manchester Univ. (UK). Schuster Lab.); Warner, D.D. (Brookhaven National Lab., Upton, NY (USA)). *Physics Letters, [Section] B;* **118**: No. 4-6, 292-296(9 Dec 1982).

The properties of the low-lying positive parity states of $_{70}{}^{160}Yb_{90}$ are reported and compared with predictions of the IBA-2 model based on parameters extrapolated from earlier calculations on the lighter, N = 90 isotones. There is good agreement between theory and experiment. The results confirm the predicted transition between the SU(3) and O(6) limits of the IBA for the N = 90 isotones, and point to a new region of O(6) symmetry.

6519 Nuclear Properties And Reactions, A=190-219

REFER ALSO TO CITATION(S) 30752, 30753, 30771

30764 (ANL—83-4, pp 144-161) **Gold standard capture cross section from 100 keV to 15 MeV.** Ryves, T.B. (National Physical Lab., Teddington, England). 1982. NTIS, PC A99/MF A01.

From NEANDC/NEACRP specialists meeting on fast-neutron capture cross sections; Argonne, IL, USA (20 Apr 1982).

The capture cross section of gold is now generally accepted as the principal reference standard, and therefore in this review only gold is considered. Recent measurements of the gold capture cross section in the unresolved region are discussed and compared with the ENDF/B-V evaluation. It is concluded that in the energy interval 100 to 2000 keV the present uncertainty in the evaluation is +-8%, in the interval 2 to 3.5 MeV the uncertainty is +-4%, in ther interval 3.5 to 14 MeV more measurements are needed before a realistic error can be assigned, and from 14 to 15 MeV the uncertainty is +-10%. Several recommendations for future work have been made.

30765 (ANU-P—817) **Yrast traps and high spin states in ^{210}Rn.** Poletti, A.R.; Dracoulis, G.D.; Fahlander, C.; Morrison, I. (Australian National Univ., Canberra. Dept. of Nuclear Physics). Jan 1982. 52p. NTIS (US Sales Only), PC A04/MF A01. Order Number DE83701489.

Yrast and near yrast states have been investigated in ^{210}Rn to high spin ($J > 30$) and high energy (10 MeV). Three different (HI, xn) reactions were used to populate the states of interest and several different γ-ray spectroscopic techniques were utilized. Three high spin yrast traps were discovered. Two de-excite by strong E3 transitions while the third decays mainly via an extremely inhibited E2 transition. The E3 decays are interpreted as allowed single particle transitions between proton or neutron states above the ^{208}Pb shell closure while the inhibited E2 transition is interpreted as indicating a substantial change in structure as the decay proceeds down the yrast line. Interpretation has been given in terms of shell model calculations.

6520 Nuclear Properties And Reactions, A=220 And Above

REFER ALSO TO CITATION(S) 30728, 30746, 30758

30766 (ANL—83-4, pp 116-124) **Calculation of average capture cross sections for actinides: level-statistical vs global approach.** Froehner, F.H.; Goel, B.; Fischer, U. (Kernforschungszentrum, Karlsruhe, Germany). 1982. NTIS, PC A99/MF A01.

From NEANDC/NEACRP specialists meeting on fast-neutron capture cross sections; Argonne, IL, USA (20 Apr 1982).

Average neutron capture cross sections have been calculated in the unresolved resonance region for many actinides, with two different methods: (1) with energy-dependent neutron strength functions obtained from a spherical optical potential adjusted to ^{238}U data, radiation strengths from the giant dipole resonance model with global parameters, and width fluctuation corrections according to Tepel et al.; (2) with constant neutron strength functions and energy-dependent radiation strengths, both from resolved resonances, and width fluctuation corrections according to Moldauer (1980). Results from the two methods are compared with each other and with experimental data.

30767 (ANL—83-4, pp 125-132) **Use of ABAREX for neutron capture calculations.** Moldauer, P.A. (Argonne National Lab., IL). 1982. NTIS, PC A99/MF A01.

From NEANDC/NEACRP specialists meeting on fast-neutron capture cross sections; Argonne, IL, USA (20 Apr 1982).

ABAREX is an optical-statistical model program for the calculation of energy averaged neutron induced nuclear reaction cross sections. The program uses the optical model algorithm of ABACUS and the statistical model method of NEARREX with many improvements and modifications. The input and output are designed to be convenient for the user and the program utilizes dynamic storage allocation with avoids fixed limits on the sizes of the various arrays. The program requires 250K storage in the IBM 370 system in its present configuration. Additional storage can easily be made available. For optical model parameter fitting, the program uses the subroutine LMDIF1 of the MINPACK-1 package of subroutines for the solution of nonlinear least square problems. No detailed description of the program will be attempted here. The capabilities and uses of the program will be outlined with special reference to neutron capture cross sections.

30768 (ANL—83-4, pp 288-301) **Fast-neutron capture in ^{238}U and ^{232}Th.** Poenitz, W.P. (Argonne National Lab., IL). 1982. NTIS, PC A99/MF A01.

From NEANDC/NEACRP specialists meeting on fast-neutron capture cross sections; Argonne, IL, USA (20 Apr 1982).

Experimental detection techniques employed in the measurements of the ^{238}U(n,γ) and ^{232}Th(n,γ) cross sections are discussed. The experimental data base is considered and it is concluded that these cross sections are presently known with 5+- in the energy range of greatest importance for LMFBR applications. New measurements will have an insignificant impact on the ^{238}U(n,γ) cross sections if they do not achieve an uncertainty of $\simeq$ 2% or less.

30769 (ANL—83-4, pp 302-313) **Absolute measurement of the cross section for 23-keV neutron activation of thorium.** Baldwin, G.T.; Knoll, G.F. (Univ. of Michigan, Ann Arbor). 1982. NTIS, PC A99/MF A01.

From NEANDC/NEACRP specialists meeting on fast-neutron capture cross sections; Argonne, IL, USA (20 Apr 1982).

Absolute measurement of the thorium radiative capture cross section has been made using antimony-beryllium photoneutrons and an activation method. The average of two determinations is 606 mb near 23 keV neutron energy with a 3.2% estimated error from all sources. This value is about 10% higher than those reported from recent measurements employing iron-filtered neutron beams.

30770 (ANL—83-4, pp 314-335) **Status of neutron capture data of ^{233}U, ^{235}U and ^{239}Pu in the unresolved resonance region.** Corvi, F. (CEC-JRC, Geel, Belgium). 1982. NTIS, PC A99/MF A01.

From NEANDC/NEACRP specialists meeting on fast-neutron capture cross sections; Argonne, IL, USA (20 Apr 1982).

First, the outstanding requests for $\alpha\gamma$ and α data of the three main fissile nuclei are briefly summarized. Then the methods employed in the last twenty years of differential α-measurements are critically discussed. They can be classified into three groups: (a) systems measuring simultaneously absorption radiation and fissions with two separate detectors; (b) systems in which a large fraction of fission and capture γ-rays are identified by means of prompt or delayed coincidences with a high efficiency fission detecting apparatus; (c) systems consisting of a γ-ray detector only, in which capture and fissions are distinguished by some special feature of the radiation emitted. Advantages and drawbacks of the various techniques are discussed, particularly in connection with all sources of systematic errors. Measurements of alpha in the unresolved resonance region are separately reviewed for each of the three fissile isotopes.

30771 (ANL—83-4, pp 336-346) **Fast neutron capture in actinide isotopes: recent results from Karlsruhe.** Wisshak, K.; Kaeppeler, F.; Reffo, G.; Fabbri, F. (Kernforschungszentrum, Karlsruhe, Germany). 1982. NTIS, PC A99/MF A01.

From NEANDC/NEACRP specialists meeting on fast-neutron capture cross sections; Argonne, IL, USA (20 Apr 1982).

Capture gamma-ray spectra of ^{241}Am, ^{240}Pu, ^{242}Pu ^{235}U and ^{197}Au were calculated in the framework of the spherical optical model and the statistical model. These spectra were used to correct experimental data for the capture cross sections of ^{240} ^{242}Pu and ^{241}Am from relative measurements using a Moxon Rae-detector with graphite converter and ^{197}Au as well as ^{235}U as standards. This correction is required to take into account that the detector efficiency is not exactly proportional to gamma-ray energy. The resulting correction factors proved to be negligible for measurements relative to ^{235}U, whereas they are $\sim$ 3% if gold is used as a standard. The capture cross section of ^{243}Am has been measured in the energy range 10 to 250 keV using kinematically collimated neutrons from the ^{7}Li(p,n) and T(p,n) reaction. The samples are positioned at flight paths of 5 to 7 cm and gold was used as a standard. Capture events were detected by two Moxon-Rae detectors with graphite and bismuth-graphite converters shielded by 0.5 to 2 cm of lead. Fission events were detected by a NE213 liquid scintillator. The present status of the experiment and some preliminary results will be presented.

30772 (ANL—83-4, pp 347-354) **Measurement of neutron capture cross section and alpha of ^{235}U from 2 to 85 keV.** Corvi, F.; Calabretta, L.; Merla, M.; van der Veen, T.; Moore, M.S. (CEC-JRC, Geel, Belgium). 1982. NTIS, PC A99/MF A01.

From NEANDC/NEACRP specialists meeting on fast-neutron capture cross sections; Argonne, IL, USA (20 Apr 1982).

The measurement was performed at the Geel linac, using a multi-plate fission chamber of known efficiency and four C_6F_6 scintillators. Two different normalizations, one based on the Au(n,γ) cross section in the keV region and the other on the thermal α value were compared and found to agree within 3%.

30773 (ANL—83-4, pp 379-393) **Some aspects of the evaluation of ^{237}Np, ^{238}Pu and ^{241}Am capture cross-sections in the unresolved region.** Derrien, H. (CEN, Cadarache, France). 1982. NTIS, PC A99/MF A01.

From NEANDC/NEACRP specialists meeting on fast-neutron capture cross sections; Argonne, IL, USA (20 Apr 1982).

The ^{237}Np, ^{238}Pu and ^{241}Am neutron cross-sections have been evaluated in the energy range from 10^{-5} eV to 14 MeV. Optical model and statistical model codes have been used to calculate the cross-sections in the unresolved region and at higher energy. The input parameters have been adjusted to reproduce the experimental data available in these energy ranges and particularly the capture cross-sections. The S_0 and S_1 strength functions obtained from resonance parameter analysis or from experimental capture cross-sections in the unresolved region have been compared to those deduced from the optical model calculations. In this paper, we present the different aspects of the evaluation related to the use of the experimental capture data as a basis in the determination of the statistical and optical model parameters.

30774 (ANL—83-4, pp 557-563) **Fast-neutron capture in fissile and fertile nuclides.** Peelle, R.W. (Oak Ridge National Lab., TN). 1982. NTIS, PC A99/MF A01.

From NEANDC/NEACRP specialists meeting on fast-neutron capture cross sections; Argonne, IL, USA (20 Apr 1982).

Extensive graphical and numerical presentations, available to the working group, assisted us in exploring the rich data base established through the labors of many skilled persons. Consistent with the meeting setting, the working group discussion concentrated on data for fast-breeder reactor (FBR) applications. All but 1 to 3% of the magnitude of cross section sensitivities of FBR parameters come from the energy region below $\approx$ 1.5 MeV, so the statistical model is the relevant theoretical concept. The Meeting emphasizes energies above $\approx$ 10 keV where resonance fluctuations are not a dominant factor. However, we should remember that approximately half the FBR sensitivity to ^{238}U capture data, as relfected in integral parameters, lies below 25 keV where resonance fluctuations are strong and resonance self-protection is a most important consideration in reactor physics. There are similar low-energy aspects to ^{239}Pu capture in that $\approx$ 30% of the FBR-parameter data sensitivity lies below $\approx$ 4 keV. Even with the discussion largely cofined to the $\approx$ 10 to 1500 keV region, the working group could only scratch the surface of the available body of information. The reader is referred to the papers presented at the Meeting and to the references contained therein in order to obtain a more detailed understanding of current issues related to fissile and fertile fast-neutron capture.

30775 (DOE/ER/02176—47) **Neutron spectroscopy. Final report.** Havens, W.W. Jr.; Melkonian, E.; Felvinci, J. (Columbia Univ., New York (USA). Dept. of Applied Physics and Nuclear Engineering). 1977. 26p. (COO—2176-47). NTIS, PC A03/MF A01. Order Number DE83010113.

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The researches carried by the Columbia University Department of Applied Physics and Nuclear Engineering, and its predecessors, in contract initially with the AEC, then with ERDA, and finally with DOE, had as its initial objective the measurement of fission cross sections and energy distributions of the fission fragments, as measured by pulse heights in detectors. These investigations sought to establish relations between the energy distributions and the quantum numbers of the resonances. In addition, some related, together with some unrelated, investigations were conducted. Progress is reported on measurements on the fissile isotopes, capture cross section measurements, theoretical developments, and the NEVIS synchrocyclotron pulsed neutron source. (WHK)

30776 (UCRL—88414) **Rapid disappearance of shell effects in the fission of transfermium nuclei.** Hulet, E.K. (Lawrence Livermore National Lab., CA (USA)). 1983. Contract W-7405-ENG-48. 13p. (CONF-830444—1). NTIS, PC A02/MF A01. Order Number DE83010366.

From International school-seminar on heavy ion physics; Alushta, USSR (14 Apr 1983).

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In the last fifteen years we have learned that nuclear shells have a very broad and pervasive impact on the fission process. In the first few decades after the discovery of nuclear fission, the nucleus was treated as a drop of liquid with smoothly varying attractive and repulsive forces. Although this model still forms the underlying basis for fission, we also observe large effects from the superimposition of shell corrections derived from coupling the quantum states of individual nucleons. The consequences of single-particle coupling on the fission process can be striking and may often overshadow that originating from the intrinsic liquid-drop component. Here, we point out several major features attributable to shell effects in the spontaneous fission (SF) of the lighter actinides, the sudden transition to symmetric fission in the fermium isotopes, and finally new experimental information indicating another transition in the SF of transfermium nuclides due to the disappearance of shell perturbations. In each transition, the abruptness is surprising, and for the moment, such rapid changes in fission behavior lack a theoretical rationale.

6530 Nuclear Theory

REFER ALSO TO CITATION(S) 30728, 30731

30777 (CEA-N—2227) **SCAT2: a spherical optical model code.** Bersillon, O. (CEA Centre d'Etudes de Bruyeres-le-Chatel, 92 - Montrouge (France)). Oct 1981. 74p. (In French). NTIS (US Sales Only), PC A04/MF A01. Order Number DE83701488.

This note describes, after a short summary of the relevant theoretical formulae, the spherical optical model code SCAT2. This code is highly modular and employs recent numerical methods, in particular for the Coulomb functions calculations. The amount of input data is kept minimal in order to make use of the program extremely simple. The listing and some test cases are given in the appendix. The code is being extensively used in the field of nuclear evaluation.

30778 (CONF-830340—1) **Nucleus-nucleus potentials.** Satchler, G.R. (Oak Ridge National Lab., TN (USA)). 1983. Contract W-7405-ENG-26. 19p. NTIS, PC A02/MF A01. Order Number DE83009799.

From International conference on heavy-ion physics and nuclear physics; Catania, Italy (21 Mar 1983).

The significance of a nucleus-nucleus potential is discussed. Information about such potentials obtained from scattering experiments is reviewed, including recent examples of so-called rainbow scattering that probe the potential at smaller distances. The evidence for interactions involving the nuclear spins is summarized, and their possible origin in couplings to non-elastic channels. Various models of the potentials are discussed.

30779 (JINR—R-2-81-780) **Problems of the theory of light nucleus inelastic interactions.** Uzhinskij, V.V. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Computing Techniques and Automation). 1981. 8p. (In Russian). NTIS (US Sales Only), PC A02/MF A01. Order Number DE83701538.

By example of $\alpha\alpha$ reactions the problems of the theory of light nucleus inelastic interactions are discussed. It is shown that the generalization of eikonal approach to inelastic nucleus reactions permits to reproduce the main characteristics of secondary particles over rapidity Rsub(y) distributions in the ^{4}He interactions at high energy. For these interactions the cross sections of collisions with defined multiplicity of inelastic interactions and the cross sections

of some processes are given. The Rsub(y) value is calculated in rough approximation and conclusion is drawn that the measurements of proton spectra are very necessary for an extention of theory. The relation of average multiplicity of particles produced in $\alpha\alpha$ interactions to the average multiplicity of particles in NN-collisions cannot exceed 2. The Rsub(y) value in the central region also cannot be more than 2. In most cases of inelastic ^{4}He nucleus interactions the processes analogous to those in hadron- nucleus collisions occur.

30780 **(JINR—R-7-81-767) Kinematics of products of two complex nuclei tangential interaction.** Tarantin, N.I. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Reactions). 1981. 16p. (In Russian). NTIS (US Sales Only), PC A02/MF A01. Order Number DE83701519.

Methods of classical mechanics are used to consider the kinematics of products of two complex nucleus tangential interaction with and without the transfer of nucleons from one nucleus to another. All possible cases of nuclear surface conjunction and interaction are analysed including both the known (rolling, stricking) and not yet considered (sliding with a blocked rotation of one nucleus, conservative tangential interaction, a plain collision with nucleon transfer and others). A total set of formulas is derived for determining spins, the energy of orbital motion and of self-rotation of products of nucleon transfer binary reaction which are convenient for calculations.

30781 **(MPA—43) Average radiation widths and the giant dipole resonance width.** Arnould, M.; Thielemann, F.K. (Max-Planck-Institut fuer Physik und Astrophysik, Garching (Germany, F.R.). Inst. fuer Astrophysik). Nov 1982. 4p. Available from Max-Planck-Institut fuer Physik und Astrophysik, Garching (Germany, F.R.).

From International conference on nuclear data for science and technology; Antwerp (Belgium) (6 - 10 Sep 1982).

The average E1 radiation width can be calculated in terms of the energy Esub(G) and width GAMMAsub(G) of the Giant Dipole Resonance (GDR). While various models can predict Esub(G) quite reliably, the theoretical situation regarding Λsub(G) is much less satisfactory. We propose a simple phenomenological model which is able to provide GAMMAsub(G) values in good agreement with experimental data for spherical or deformed intermediate and heavy nuclei. In particular, this model can account for shell effects in GAMMAsub(G), and can be used in conjunction with the droplet model. The GAMMAsub(G) values derived in such a way are used to compute average E1 radiation widths which are quite close to the experimental values. The method proposed for the calculation of GAMMAsub(G) also appears to be well suited when the GDR characteristics of extended sets of nuclei are required, as is namely the case in nuclear astrophysics.

30782 **Classifying the singularity in the deformation shape of the liquid-drop model.** Alesso, H.P.; Smith, C.F. (California Univ., Livermore (USA). Lawrence Livermore Lab.). *Nuovo Cimento [Sezione] A;* **66**: No. 3, 272-282(1 Dec 1981).

Microfiche only, copy does not permit paper copy reproduction2 refs.

The deformation shape of the liquid-drop model of nuclear fission can be excellently represented by the Legendre-polynomial expansion method. Unfortunately, in the past, it has appeared necessary to include a large number of higher-order terms in order to describe the more deformed shapes encountered in the later stages of fission. In this paper, the degenerate singularity that occurs in the Businaro-Gallone-Swiatecki representation of the Legendre-polynomial expansion of the deformation shape for the slightly distorted ground state is classified. In the present analysis the singularity has been found to be double-degenerate and strongly 3-determinate. As a result, it has been classified as a hyperbolic-umbilic elementary catastrophe. In order to make the potential function of the singularity a universal unfolding, two new control parameters for the liquid-drop model are introduced.

30783 **Nuclear states and shapes at high spin.** Diamond, R.M. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). *Nukleonika;* **26**: No. 3, 337-372(1981).

From 13. Summer school in nuclear physics; Mikolajki (Poland) (1 - 13 Sep 1980).

71 refs.

As angular momentum is added to a nucleus, the balance of forces acting upon it to determine its shape, moment of inertia, mode of rotation, and type of level structure may undergo a series of changes. At relatively low spins a deformed nucleus will rotate collectively, and one may see the effect of Coriolis anti-pairing in gradually increasing the moment of inertia. Around spin 12-16 ($h/2\pi$) there may be an abrupt change (backbending) when a pair of high-j nucleus unpair and align with the axis of rotation, thus allowing the nucleus to slow its collective rotation. This process, the start of a sharing of angular momentum between single-particle motion and the collective rotation, gives a lower total energy and corresponds to a change towards triaxiality in the shape of the nucleus. At much higher spins we can no longer observe discrete γ-ray transitions, but are in the regime of continuum spectra; all the information on these high-spin states (to 65 ($h/2\pi$)) is contained in these continuum cascades. We are beginning to learn how to study these spectra, experimentally and theoretically, and new techniques offer promise of letting us extract a great deal of information about the shapes and properties of very high spin states.

30784 **Spin and isospin fluctuations in heavy ion collisions and their dependence upon the shape of the dinuclear complex.** Moretto, L.G. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). *Nukleonika;* **26**: No. 3, 425-470(1981).

From 13. Summer school in nuclear physics; Mikolajki (Poland) (1 - 13 Sep 1980).

Paper copy only, copy does not permit microfiche production3 refs.

The relevance of higher multipoles of giant isovector modes in the charge distribution of deep inelastic fragments is discussed and found to depend strongly on mass asymmetry. The sources of angular momentum fluctuations are investigated. Quantal effects are considered as well as effects arising from non-equilibrium and equilibrium statistical fluctuations. A model based upon equilibrium statistical mechanics is considered in detail and used to predict both 2nd moments of the angular momentum distributions and the angular momentum misalignment. Analytical expressions are derived to calculate the angular distributions of sequentially emitted particles, fission fragments, as well as gamma rays in terms of the angular momentum misalignment. Recent data on the angular distributions of sequential alphas, fission and gamma rays are analyzed in terms of the model.

6540 Radiation And Shielding Physics

REFER ALSO TO CITATION(S) 29269, 29274, 29281, 30266, 30293, 30293

30785 (ANL—82-80, pp 181-189) **Dynamic range aspects of pulsed source instruments.** Mezei, F. (Institut Laue-Langevin, Grenoble, France). Jan 1983. NTIS, PC A99/MF A01.

From 6. annual international collaboration of advanced neutron sources meeting; Argonne, IL, USA (28 Jun 1982).

In recent applications of neutron scattering the dynamic range is found to be an important aspect of instrument performance along with neutron flux and resolution. It is pointed out that due to the inherent use of a broad wavelength band, certain instruments, like small angle scattering and neutron spin echo spectrometers, provide better dynamic range capability on a pulsed source than on a continuous source.

30786 (ANL—82-80, pp 279-289) **Crystal analyzer TOF spectrometer (CAT) for high energy incoherent neutron scattering.** Watanabe, N. (National Lab. for High Energy Physics, Oho, Ibaraki, Japan); Ikeda, S.; Kai, K. Jan 1983. NTIS, PC A99/MF A01.

From 6. annual international collaboration of advanced neutron sources meeting; Argonne, IL, USA (28 Jun 1982).

This paper reports the design and performance of a high resolution crystal analyzer spectrometer which has been built and operated at KENS. Energy resolution of the instrument is $\Delta\epsilon/\epsilon = 0.02 \sim 0.03$ in the range of energy transfer $\epsilon = 0.5 \sim 1$ eV. With

this spectrometer, the local mode of hydrogen in various metallic hydrides have been measured. In the case of TiH_2 or ZrH/sub x/, higher harmonics of the optical peaks have been detected up to 5th orders, with their fine structures. Higher order peaks of $TaH_{0.5}$ have also been detected. The optical mode in hydrogenated metallic glass of $NiTiH_{0.5}$ has been measured and compared with that in crystalline sample.

30787 (ANL—82-80, pp 503-528) **Computational methods for high-energy source shielding.** Armstrong, T.W.; Cloth, P.; Filges, D. (Kernforschungsanlage Juelich GmbH, Germany). Jan 1983. NTIS, PC A99/MF A01.

From 6. annual international collaboration of advanced neutron sources meeting; Argonne, IL, USA (28 Jun 1982).

The computational methods for high-energy radiation transport related to shielding of the SNQ-spallation source are outlined. The basic approach is to couple radiation-transport computer codes which use Monte Carlo methods and discrete ordinates methods. A code system is suggested that incorporates state-of-the-art radiation-transport techniques. The stepwise verification of that system is briefly summarized. The complexity of the resulting code system suggests a more straightforward code specially tailored for thick shield calculations. A short guide line to future development of such a Monte Carlo code is given.

30788 (CONF-820998—4) **Inelastic cross sections for electron interactions in liquid water.** Hamm, R.N.; Ritchie, R.H.; Turner, J.E.; Wright, H.A. (Oak Ridge National Lab., TN (USA)). 1982. Contract W-7405-ENG-26. 5p. NTIS, PC A02/MF A01. Order Number DE83009773.

From Workshop on the interface between radiation physics and radiation chemistry; Argonne, IL, USA (9 Sep 1982).

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The task was to develop a set of cross sections for electron inelastic processes in liquid water suitable for use in a Monte Carlo transport calculation. Results are plotted as inverse mean free paths vs electron energy. (DLC)

30789 (CONF-8105215—1) **Factorization methods in linear-transport theory.** Kaper, H.G. (Argonne National Lab., IL (USA)). 1981. Contract W-31-109-ENG-38. 21p. NTIS, PC A02/MF A01. Order Number DE83010598.

From Toeplitz memorial conference; Tel-Aviv, Israel (11 May 1981).

Time-independence linear-transport problems in plane-slab configurations are described abstractly by differential equations of mixed forward-backward type. The solution of boundary value problems requires the introduction of extension operators, whose existence reflects the factorization property of the symbol of the transport equation. In this article we use the simplest model transport equation to illustrate the structure of these problems. We also indicate various generalizations that have been investigated in the context of linear-transport theory.

30790 (FEI—1038) **A2F computer code for data preparation to carry out group calculations by the Monte Carlo method on the basis of the ARAMAKO-2F system.** Korobejnikov, V.V. (Gosudarstvennyj Komitet po Ispol'zovaniyu Atomnoj Ehnergii SSSR, Obninsk. Fiziko-Ehnergeticheskij Inst.). 1981. 11p. (In Russian). NTIS (US Sales Only), PC A02/MF A01. Order Number DE83700419.

The A2F computer code for preparation of constants for reactor multigroup calculations by the Monte Carlo method in 26-group approximation on the basis of the ARAMAKO-2F system is described. The A2F computer code scheme and the instruction on data preparation are given. Initial data consist of three sections: initial data to the constant preparation computer code, initial data to the MMK22 subcode, initial data to the geometric module.

30791 **Calculation of the diffusion constant of muons in metals at low temperatures.** Jaeckle, J. (Konstanz Univ., Germany); Kehr, K.W. *Muon SR Newsletter;* No. 28, 1386-1399(24 Dec 1982).

The diffusion constant of muons in metals at low temperatures is derived from the muon Boltzmann equation under the assumption that electron-muon scattering dominates, and a T^{-1} behaviour is obtained. This temperature dependence compares favourably with the experimentally determined diffusion constant prop. $T^{-0.6}$ for positive muons in aluminum. But the calculated absolute value of the diffusion constant around 1K is still in severe disagreement with experiment.

30792 **Muonium in ultra-pure germanium.** Doering, K.P. (Stuttgart Univ., Germany); Haas, N.; Haller, E.E.; Herlach, D. *Muon SR Newsletter;* No. 28, 1400-1406(24 Dec 1982).

The spin precession signals of positive muons (μ^+) implanted into Ge single crystals of ultra-high purity (electronically active impurity concentration $\leqq 3.10^{11}$ cm^{-3}) containing between 10^{13} cm^{-3} and 10^{17} cm^{-3} Si have been investigated at temperatures ranging from 5 K to 280°K in magnetic fields of 0.3 mT to 27.5 mT applied perpendicular to the μ^+ polarization. As in previous work, the spin precession of muons in diamagnetic environments [μ^+] and of normal (isotropic) muonium [Mu = μ^+e^-)] as well as of anomalous (anisotropic) muonium [Mu] were observed. The damping of the Mu signal increases drastically with increasing Si content. This indicates that the muonium diffuses rather rapidly through the Ge matrix and interacts with solute Si atoms.

30793 **Extracting maximal information on positive muon diffusion in metals.** Leon, M. (Los Alamos National Laboratory, NM). *Muon SR Newsletter;* No. 27, 1250-1254(1 Jul 1982).

A discussion is given on how combining zero- and longitudinal-field μSR can give more information on the motion of the μ^+ in the target than zero-field studies alone.

30794 **Theory of muon spin relaxation due to the hopping motion of positive muons in ferromagnets.** Seeger, A. (Max-Planck-Inst. fuer Metallforschung, Stuttgart, Germany); Monachesi, P. (Los Alamos National Laboratory, NM). *Muon SR Newsletter;* No. 27, 1270-1320(1 Jul 1982).

The interaction of the magnetic moments of spin-polarized positive muons with the magnetic fields at the interstices in ferromagnetic (or ferrimagnetic) materials may be used to study the localization and the hopping motion of thermalized muons by observing the relaxation of the longitudinal or transverse spin polarization or the shift of the muon spin precession frequency as a function of the orientation of a strong applied magnetic field. The general theory is developed and applied to the special cases of muon diffusion between two types of interstices of tetragonal symmetry in body-centered cubic metals (α-Fe) or of cubic symmetry in face-centered cubic metals (Ni). It is shown that by a suitable choice of the strength and the crystallographic direction of the applied magnetic field quite detailed information on the quantum diffusion of positively charged light particles in crystals may be obtained.

30795 **Diffusion and trapping of positive muons in niobium.** Boekema, C. (Los Alamos National Lab., NM); Heffner, R.H.; Hutson, R.L.; Leon, M.; Schillaci, M.E.; Kossler, W.J.; Numan, M.; Dodds, S.A. *Muon SR Newsletter;* No. 27, 1321-1342(1 Jul 1982).

Using zero- and longitudinal-field μSR, the conventional interpretation of the double-humped behavior of the μ^+-depolarization rate in Nb has been established unambiguously. Thus the μ^+ mobility is shown to increase monotonically with temperature. The widths of the magnetic field distributions (due to the Nb nuclear moments) and the rates for finding or escaping from traps have been measured at several temperatures. In addition, equations are presented which govern the time-evolution of the μ^+ polarization, when the muons are finding traps, escaping from traps, or both, for zero, longitudinal, and transverse external magnetic fields. A method for including the effect of more than one kind of trap acting at a particular temperature is given.

30796 **Low-temperature mobility of positive muons in pure copper.** Seeger, A. (Max-Planck-Institut fuer Metallforschung, Stuttgart, Germany). *Muon SR Newsletter;* No. 27, 1356-1366(1 Jul 1982).

For the recently discovered mobility of positive muons in pure copper at liquid-helium temperatures a model based on transitions from metastable to stable interstitial sites is proposed and

shown to be in good agreement with the observations. Several additional experimental tests of this interpretation are suggested.

30797 **Diffraction crystals for sagittally focusing x-rays.** Ice, G.E.; Sparks, C.J. Jr. US Patent Application 6-385,993. 7 Jun 1982. 21p. Contract W-7405-ENG-26.

The invention is a new type of diffraction crystal designed for sagittally focusing photons of various energies. The invention is based on the discovery that such focusing is not obtainable with conventional crystals because of distortion resulting from anticlastic curvature. The new crystal comprises a monocrystalline base having a front face contoured for sagittally focusing photons and a back face provided with rigid, upstanding, stiffening ribs restricting anticlastic curvature. When mounted in a suitable bending device, the reflecting face of the crystal can be adjusted to focus photons having any one of a range of energies.

30798 **On the advantages of invariant imbedding for the calculation of deep-penetration problems.** Hughes, H.G.; Faber, V.; White, A.B. Jr.; Wing, G.M. (Los Alamos National Laboratory, P.O. Box 1663, Los Alamos, NM 87545). *Transactions of the American Nuclear Society;* **41**: 486-487(Jun 1982). (CONF-820609—).

From American Nuclear Society annual meeting; Los Angeles, CA, USA (6 Jun 1982).

30799 **Advances in discrete-ordinates electron transport.** Morel, J.E.; Wienke, B.R. (Los Alamos National Laboratory, P.O. Box 1663, Los Alamos, NM 87545). *Transactions of the American Nuclear Society;* **41**: 475-476(Jun 1982). (CONF-820609—).

From American Nuclear Society annual meeting; Los Angeles, CA, USA (6 Jun 1982).

30800 **Energy spectra of heavy fragments from the interaction of protons with communications materials.** Hamm, R.N.: Rustgi, M.L.; Wright, H.A.; Turner, J.E. (Oak Ridge National Lab., TN). *IEEE (Institute of Electrical and Electronics Engineers) Transactions on Nuclear Science;* **NS-28**: No. 6, 4004-4006(Dec 1981). Contract W-7405-ENG-26.

A Monte Carlo computer code is used to calculate the energy spectra of recoil nuclei resulting from interactions of protons with communications materials. Results are presented for 130 MeV and 1 GeV protons incident on O, Si, Ga, As, and Au. The results for 130 MeV protons on Si are compared with previous calculations and measurements.

30801 **Straggling and plasmon excitation in the energy loss spectra of electrons transmitted through carbon.** Ashley, J.C. (Oak Ridge National Lab., TN); Cowan, J.J.; Ritchie, R.H.; Anderson, V.E.; Hoelzl, J. *Thin Solid Films;* **60**: 361-370(1979). Contract W-7405-ENG-26.

A model is described for the calculation of differential inverse mean free paths (DIMFPs) for the inelastic interactions of electrons with solids. The energy loss function $\mathrm{Im}[-1/\epsilon(q,\omega)]$ is represented as a sum of Drude-type functions. The adjustable parameters in the energy loss function are fixed by a fit to the energy loss function in the optical limit ($q \rightarrow 0$) obtained from data on the optical constants of glassy carbon. The extension of the optical energy loss function to arbitrary values of q in this model leads to an analytical expression for the DIMFP. Energy loss spectra for low energy electrons (less than 2000 eV) transmitted through carbon foils of various thicknesses are determined by solving the transport equation using a convolution method and the DIMFPs determined as described above. Comparisons of these calculated spectra with those measured by Jacobi show that the model provides a good description of both the broad straggling distribution and the fine structure due to plasmon excitation.

6550 Medical Physics

30802 **(AECL—7409) Progress report, Health Sciences Division, 1 April - 30 June, 1981.** (Atomic Energy of Canada Ltd., Chalk River, Ontario. Chalk River Nuclear Labs.). Sep 1981. 113p. (PR-HS—8). NTIS (US Sales Only), PC A06/MF A01. Order Number DE83700427.

Calculations of absorbed doses and dose equivalents at various depths in a cylindrical tissue equivalent phantom by monoenergetic neutrons and calculations of quality factors for monoenergetic neutrons in tissue have been extended to neutron energies up to 14.7 MeV. Irradiations of human lymphocytes with low doses of ^{60}Co gamma rays and 14.6 MeV neutrons show a lower initial incidence of DNA strand breaks produced by neutrons than by gamma radiation. Tests are in progress on the relative thermal neutron sensitivities of various commonly used types of TLD phosphor. Studies on soil columns contaminated with radioactive cesium have demonstrated the release of a small portion of the cesium present on the column on filterable particles. Work on the bioavailability of ^{60}Co present in groundwater has indicated that complexed ^{60}Co is less available to plants than added free cobalt. A liquid scintillation method has been successfully used to measure radon-222 in bedrock groundwater. Radiation Biology research activities have been concerned mainly with effects of radiation and tumor promoters on the DNA in blood lymphocytes, a new method of preparing plasmid DNA, relation of oxygen and various free radicals to radiation-induced lethality and genetic changes in yeast, the functions of different DNA repair systems in yeast, induction of DNA damage by ultraviolet light, relationship of radiation sensitivity to hereditary deficiencies in DNA repair systems in cultured human cells, relative biological effectiveness of tritium beta-radiation for induction of breast cancer in rats and the follow-up of past CRNL employees. Metabolic studies were also conducted.

30803 **(AECL—7513) Progress report, Health Sciences Division, 1 July - 30 September, 1981.** (Atomic Energy of Canada Ltd., Chalk River, Ontario. Chalk River Nuclear Labs.). Dec 1981. 104p. (PR-HS—9). NTIS (US Sales Only), PC A06/MF A01. Order Number DE83700429.

Monte Carlo calculations of the dose index and dose-equivalent index for fields of monoenergetic neutrons from thermal energies to 14.7 MeV are in progress. The evaluation of MgB_4O_7:Dy as thermoluminescent dosimeters is continuing. Some factors that limit the accuracy of TLD readings have been investigated. Prototypes of a new portable personal tritium monitor have been evaluated at various nuclear power stations and at CRNL. Various methods of correcting Geiger counter rates for large dead-time losses are under investigation. An area has been selected as the site for a large-scale tracer injection test where groundwater flow behaviour in an area of predominantly vertical movement will be studied and modelled. The project 'Bedrock-groundwater/Lake-connection' is underway. A new method for counting carbon-14 at low levels has been tested. The release of approximately 130 TBq (3500 curies) of tritiated water from the NPD site over a 7-day period in August has provided an opportunity to study dispersion in the Ottawa River. Work in the Radiation Biology Branch has dealt with both the nature of DNA damage by radiation and the response of cells as they attempt to repair this injury.

30804 **(AERE-R—10385) SABRE: a computer-based system for the assessment of body radioactivity by photon spectrometry. Part 4.** Venn, J.B. (UKAEA Atomic Energy Research Establishment, Harwell. Environmental and Medical Sciences Div.). Feb 1982. 58p. NTIS (US Sales Only), PC A02/MF A01. Order Number DE83701542.

A PDP-11/10 computer system is described for the acquisition and processing of pulse height spectra from detectors used for the measurement of body radioactivity. Version 4 of SABRE (System for the Assessment of Body Radioactivity) provides control of multiple detection systems from visual display consoles by means of a command language. A wide range of facilities is available for the display, processing and storage of acquired spectra and complex operations may be pre-programmed by means of the SABRE MACRO language. The hardware includes a CAMAC interface to the detection systems, disc cartridge drives for mass storage of data and programs, and data-links to other computers. The software is written in assembler language and includes special features for the dynamic allocation of computer memory and for safeguarding acquired data.

30805 (ANL—82-80, pp 605-617) **Methods of neutron and proton dosimetry at spallation sources.** Greenwood, L.R.; Popek, R.J. (Argonne National Lab., IL). Jan 1983. NTIS, PC A99/MF A01.

From 6. annual international collaboration of advanced neutron sources meeting; Argonne, IL, USA (28 Jun 1982).

A variety of techniques are being developed to measure the neutron and proton fluxes and energy spectra at spallation neutron sources. Multiple-activation dosimetry is being used to adjust the neutron energy spectrum by a least-squares procedure. Primary beam protons are measured by the $^{27}Al(p,*)\ ^{22}Na$ reaction and secondary protons by (p,n) reactions on ^{7}Li, ^{51}V, and ^{65}Cu. Lithium fluoride thermoluminescent dosimeters are used to measure the neutron dose rate, although we have been unable to determine the much weaker gamma dose rate. Neutron fluxes, displacement damage, gas production and transmutation, and dose rates are now routinely determined for materials irradiations with uncertainties of 10 to 15%.

30806 (JINR—R-16-81-607) **Determination of maximum neutron dose equivalent in the 10^{-8}-25 MeV energy range using thermal neutron detector with two moderators.** Alejnikov, V.E.; Bamblevskij, V.P.; Be En Gvan. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1981. 7p. (In Russian). NTIS (US Sales Only), PC A02/MF A01. Order Number DE83701493.

Method for measuring neutron dose equvalent in the energy range of less than 25 MeV is described. Moderated thermal neutron detector with two polyethylene moderator spheres 5 and 10 inches in diameter is used. Systematic error is estimated to be less than 30% in the radiation fields behind the shielding of accelerators upto 10 GeV particle energy and of nuclear reactors.

6560 Solid State Physics

REFER ALSO TO CITATION(S) 30727, 30728

30807 (AECL—7416) **Progress report, Chemistry and Materials Division, 1 April - 30 June, 1981.** (Atomic Energy of Canada Ltd., Chalk River, Ontario. Chalk River Nuclear Labs.). Aug 1981. 93p. (PR-CMa—57). NTIS (US Sales Only), PC A05/MF A01. Order Number DE83700428.

The work of the Division in the areas of solid state science, radiation, physical and analytical chemistry, and materials science during the quarter is described. Measurements of ion stopping power have emphasized the importance of axial symmetry and may be used to show the contribution of nuclear inelastic events to stopping processes. Enhancement of ion scattering at 180 degrees can occur even in the first few layers of a single crystal of gold implanted with heavy atoms. Agreement has been obtained between experimental and calculated rates for dechanneling of protons in gold. The rate of decomposition of HOI in aqueous solutions has been determined. The effects of radiation on dithiothreitol is being studied. Laser photochemistry work includes investigations of multiphoton dissociation and of laser-induced zirconium isotope separation. A method has been found for the preparation of oxygen gas samples for the determination of oxygen isotope ratios in water, and high-performance liquid chromatography has been applied to metals in ground water. Sputtered coatings of stainless steel on the surface of zircaloy fuel cladding reduce the oxidation rate in steam. A theoretically-based design equation for irradiation growth of pressure tubes has been developed. Studies on the effect of small strains on zircaloy-2 tubing show the need to avoid even small amounts of compressive deformation of calandria tubes.

30808 (JINR—5-82-67) **Existence of positive solutions in the Lindner-Fedyanin model.** Zhidkov, P.E. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Computing Techniques and Automation). 1982. 10p. (In Russian). NTIS (US Sales Only), PC A02/MF A01. Order Number DE83700185.

The 3-dimensional Lindner-Fedyanin model is studied. The variational method applied to one problem is generalized. For the nonlinear elliptical equation which appears at considering solutions of special type sufficient conditions of the existence of nontrivial solution (u, v) of the problem, where $u>0$, $v>0$ are investigated.

30809 (JINR—5-82-68) **Particle-like solutions in some models of nonlinear physics.** Zhidkov, P.E. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Computing Techniques and Automation). 1982. 8p. (In Russian). NTIS (US Sales Only), PC A02/MF A01. Order Number DE83700186.

The nonlinear common 2-nd order differential equation is studied. The method of qUalitative theory of usual differential equations is used. The sufficient conditions of the existence of partile-like solutions with some zeros are obtained. Their qualitative properties are investigated. The result is applied to two physical models.

30810 (JINR—R-2-81-822) **New exactly solvable systems of differential-difference equations.** Makhaldiani, N.V.; Makhan'kov, V.G. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Computing Techniques and Automation). 1981. 12p. (In Russian). NTIS (US Sales Only), PC A02/MF A01. Order Number DE83700192.

Two new nonlinear evolution equations are considered. One of them describes a matrix generalization of the Hubbard model, another is the matrix differential-difference analog of nonlinear Schroedinger equation. In the coherent state representation and long wave limit these both lead to a matrix nonlinear Schroedinger equation. For the second equation the Lax representation is constructed, so the integrability via the inverse scattering transform is established. The recent progress in Monte Carlo computation of path integrals arised in quantum field theories and in condensed matter physics related to the generalized Hubbard model is discussed.

30811 **Topological and group theoretical analysis in dynamic nuclear magnetic resonance spectroscopy.** Balasubramanian, K. (Univ. of California, Berkeley). *Journal of Physical Chemistry;* **86**: No. 24, 4668-4674(25 Nov 1982). Contract AC03-76SF00098.

A method is developed for constructing NMR reaction graphs which give the NMR signal and intensity ratio patterns. This is done by generating the irreducible representations spanned by nuclei (whose NMR are of interest) with generating functions obtained from group character cycle indices (GCCI's). The method generates the symmetry species spanned by the nuclei in both the rigid and nonrigid groups without having to know the character of the representation spanned by nuclei. For nonrigid molecules which exhibit internal rotations the GCCI's can be obtained without having to know their character tables. We outline a double-coset technique to obtain the equivalence classes of nuclei and thus to construct NMR reaction graphs. Using this technique one can obtain the NMR signal and intensity ratio patterns. We introduce the concept of restricted character cycle indices (RCCI's) which generate the irreducible representations spanned by a given equivalence class of nuclei. This in turn enables the prediction of coalescence, splitting patterns, and intensity ratios of NMR signals in dynamic processes. Applications to spontaneous generation of chiral signals are outlined, where a nonrigid molecule which possesses no chiral signals suddenly possesses chiral signals (which can be resolved with chiral shift reagents) at lower temperatures.

30812 **Core excitons in Ga-V compound semiconductors.** Hjalmarson, H.P.; Buettner, H.; Dow, J.D. (Univ. of Illinois, Urbana). *Physics Letters [Section] A;* **85**: No. 5, 293-294(5 Oct 1981). Contract AC02-76ER01198.

In this letter we employ the theory of deep impurity levels in semiconductors to compute the core exciton energies of Ga 3d Frenkel core excitons in GaP, GaAs, and GaSb. We determine the electron-hole interaction potential by means of the $Z + 1$ or optical alchemy approximation: the core hole is presumed to have a sufficiently small radius that its charge distribution resembles that of a nuclear proton; the core-excited Ga is transmuted by the excitation into a Ge impurity. The dipole selection rules for excitation by synchrotron radiation require that the final electron orbital be either p-like or f-like; we assume that the p-like (or T_2-symmetric) orbital dominates in these sp^3-bonded semiconductors. Thus we compute the energy of the T_2 orbital of a Ge substitutional defect relative to the lowest conduction band edge.

30813 Spatial dispersion effects in the interaction between metal surfaces. Ashley, J.C. (Oak Ridge National Lab., TN); Ritchie, R.H.; Echenique, P.M. *Solid State Communications;* **40**: 599-601(1981). Contract W-7405-ENG-26.

A simple quantum mechanical description of two interacting metal half-spaces is presented. Plasmon dispersion and single-particle excitation are included in a phenomenological fashion via a plasmon-pole model. The van der Waal's energy calculated for the system is in good agreement with the results obtained by other workers using the random-phase approximation.

30814 Thermodynamic parameters in the earth as determined from seismic profiles. Brown, J.M. (Texas A and M Univ., College Station); Shankland, T.J. *Geophysical Journal of The Royal Astronomical Society;* **66**: 579-596(1981). Contract W-7405-ENG-36.

A Debye model using two cut-off frequencies corresponding to compressional and shear velocities is used to calculate mineral entropies. This model permits entropy and heat capacity in the earth to be calculated from seismic profiles, and iteration yields temperature profiles along an isentrope. With an adiabatic temperature profile it is possible to obtain Grueneisen's parameter and thermal expansion as a function of depth. Only in the lower mantle is the calculated Grueneisen's parameter alone an isentrope approximately proportional to volume. 45 references, 7 figures.

6561 Superconductivity

30815 Structure of thermal radiation field in an optically thick limit. Ahluwalia, R.K.; Im, K.H. (Argonne National Lab., IL). *AIAA (American Institute of Aeronautics and Astronautics) Journal;* **20**: 1766-1769(Dec 1982).

The transport of radiation in the optically thick limit is investigated when the temperature profile within the medium is specified and continuous, and when the medium under consideration is not in radiative equilibrium. Results show that the equation governing the transport of incident radiation becomes mathematically singular as the optical thickness becomes large. It is shown that this singularity is an attribute of a small parameter epsilon, which is inversely proportional to the square of the optical thickness, multiplying the highest derivative of the differential equation. It is found that in the optically thick limit, away from the wall the radiation field is near equilibrium, such that up to 0(epsilon) the rates of absorption and emission of radiation are equal. In the near-wall region, however, the absorption and emission rates are different by 0(epsilon to the 1/2). Thus, the magnitude of the divergence of radiative heat flux changes by 0(epsilon to the 1/2) as the wall is approached from the far region, and there exists a radiation boundary layer for the incident radiation in the limit of optical thickness becoming very large.

6570 Theoretical Physics

REFER ALSO TO CITATION(S) 30302, 30699, 30699, 30831, 30835, 30839, 30840

30816 (IFVE-OTF—82-3) Some classical effects in static spherically symmetric gravitational field in field gravitational theory. Vlasov, A.A. (Gosudarstvennyj Komitet po Ispol'zovaniyu Atomnoj Ehnergii SSSR, Serpukhov. Inst. Fiziki Vysokikh Ehnergij). 1982. 14p. (In Russian). NTIS (US Sales Only), PC A02/MF A01. Order Number DE83700182.

The case of static spherically symmetric source of gravity is under consideration in field gravitational theory (FGT). Expressions for perihelion shift, deflection of light rays and delay of radiosignals are obtained in post-postnewtonian appxoximation. These results are compared with those in GRT. Also the motion of particles is under consideration in strong gravitational field in FGT and new effects are pointed out: the presence of gravitational repulsive forces at short distances, the absence of so called "black holes" and so on. The Einstein theory does not possess these effects, they are inherent only to FGT with minimal coupling.

30817 (ITEP—125(1981)) Loop equations in the theory of gravitation. Makeenko, Yu.M.; Voronov, N.A. (Gosudarstvennyj Komitet po Ispol'zovaniyu Atomnoj Ehnergii SSSR, Moscow. Inst. Teoreticheskoj i Ehksperimental'noj Fiziki). 1981. 21p. NTIS (US Sales Only), PC A02/MF A01. Order Number DE83701506.

Loop-space variables (matrices of parallel transport) for the theory of gravitation are described. Loop equations, which are equivalent to the Einstein equations, are derived in the classical case. Loop equations are derived for gravity with cosmological constant as well. An analogy with the loop-space approach in Yang-Mills theory is discussed.

30818 (JINR—R-2-81-849) Generalized Hamilton-Jacobi theory for particles with intrinsic angular momentum. Yamaleev, R.M. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Computing Techniques and Automation). 1981. 16p. (In Russian). NTIS (US Sales Only), PC A02/MF A01. Order Number DE83700193.

Using the procedure of factorization of findamental correlation of classical mechanics expressions for correlation between energy momentum and angular momentum are obtained. The vector analogy of scalar function of action is introduced through which energy momentum and angular momentum are expressed. The second order differential equation for vector function is obtained. It is shown that the obtained equation describes motion of a classical particle with intrinsic angular momentum. In quantum case the considered equation converts to the Pauli equation for particles with spin 1. It is shown that the classical second order differential equation coincides with that of the first degree $h/2\pi$ in the semiclassical approximation of the Pauli equation for spin 1 for $S=S^*$, where S^* is the solution of Hamilton-Jacobi equation. The analogous investigation is performed for relativistic case, where the correspondence of classical equations for particles with intrinsic angular momentum and the Proca equation for spin 1 is established.

30819 (JINR—R-11-81-856) Solution of high order of accuracy of the Sturm-Liouville partial problem for a system of differential equations of a special type. Melezhik, V.S.; Somov, L.N. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Computing Techniques and Automation). 1981. 8p. (In Russian). NTIS (US Sales Only), PC A02/MF A01. Order Number DE83700189.

A computational scheme of a high order of accuracy for solving a system of differential equations of a special type is suggested. Possibilities and peculiarities of algorithm realization are demonstrated by the calculation of μ-mesomolecule levels of hydrogen isotopes. The computational scheme under consideration functions stably in the whole discrete spectrum region of mesic molecules and its error at calculating the energy of the levels for a big grid of potentials representation (h=0.1) is approximately 3×10^{-3} eV. The use of the suggested algorithm within the framework of the adiabatic method enables to increase the accuracy of energy calculations for mesic molecule levels up to 10^{-2} - 10^{-3} eV.

30820 Interpretation of fine entropy from non-conservative statistical mechanics. Guiasu, S. (Universite du Quebec, Trois-Rivieres); Fronteau, J. *Hadronic Journal;* **5**: No. 5, 1627-1631(Aug 1982). (CONF-820136—).

From 1. international conference on non-poteatial interactions and their Lie-admissible treatment; Orleans, France (5 Jan 1982).

A link is established between the notion of a fine entropy and the difference between two distortions in Kullback's sense.

30821 Reciprocity principle in stochastic quantum mechanics. Brooke, J.A.; Guz, W.; Prugovecki, E. (Univ. of Toronto, Ontario). *Hadronic Journal;* **5**: No. 5, 1717-1733(Aug 1982). (CONF-820136—).

From 1. international conference on non-potential interactions and their Lie-admissible treatment; Orleans, France (5 Jan 1982).

Born's reciprocity theory can be combined with a recently proposed framework for quantum spacetime by requiring that the free test particle propagators obey the Born-Lande equation in ad-

dition to the Klein-Gordon equation. If, furthermore, the coordinate transition amplitudes in between various standards are required to be eigenfunctions of Born's metric operator, then a mass formula results which predicts linear dependence on spin of the squared rest mass of elementary particles. This procedure also leads to a guage and reciprocally invariant formulation of the relativistic canonical commutation relations.

30822 Classical mechanics and constants of motion. Steeb, W.H. (Universitaet Paderborn, Germany). *Hadronic Journal;* 5: No. 5, 1738-1747(Aug 1982). (CONF-820136—).

From 1. international conference on non-potential interactions and their Lie-admissible treatment; Orleans, France (5 Jan 1982).

We give three theorems concerning constants of motion in classical mechanics.

30823 Second virial coefficient of one dimensional gas. Mijatovic, M. (Univ. of Skopje, Yugoslavia). *Hadronic Journal;* 5: No. 5, 1774-1780(Aug 1982). (CONF-820136—).

From 1. international conference on non-potential interactions and their Lie-admissible treatment; Orleans, France (5 Jan 1982).

The second virial coefficient of a one dimensional gas is calculated using the expressions for the scattering amplitude. The scattering amplitude is chosen in the form of rational function of wave vector.

30824 Quantization, non-locality and lie-admissible formulations. Broadbridge, P. (Western Australian Inst. of Tech., South Bentley). *Hadronic Journal;* 5: No. 5, 1842-1858(Aug 1982). (CONF-820136—).

From 1. international conference on non-potential interactions and their Lie-admissible treatment; Orleans, France (5 Jan 1982).

If higher order wave equations are reduced to first order by supplementary conditions, then quadratic Hamiltonians of the most general type will emerge. Even then, for several reasons elaborated below, canonical quantization can still not be applied consistently. The benefit of clinging to a Lagrangian description of non-localized phenomena is then questionable. Non canonical quantization procedures should be considered. Some initial attempts at Lie-admissible quantization are examined critically here, and it is concluded that further recourse to experiment seems to be necessary.

30825 Principle of least action; some possible generalizations. Broucke, R. (Univ. of Texas, Austin). *Hadronic Journal;* 5: No. 5, 1901-1922(Aug 1982). (CONF-820136—).

From 1. international conference on non-potential interactions and their Lie-admissible treatment; Orleans, France (5 Jan 1982).

In this article we draw the attention to an important variational principle in dynamics: the Maupertuis-Jacobi Least Action Principle (MJLAP). This principle compares varied paths with the same energy h. We give two new proofs of the MJLAP (Sections 3 and 8) as well as a new unified variational principle which contains both Hamilton's Principle (HP) and the MJLAP as particular cases (Sections 4 and 9). The article also shows several new methods for the construction of a Lagrangian for a conservative dynamical system. As an example, we illustrate the theory with the classical Harmonic Oscillator Problem (Section 10). Our method is based on the theory of changes of independent variables in a dynamical system. It indirectly shows how a change of independent variable affects the self-adjointness of a dynamical system (Sections 5, 6, 7). Our new Lagrangians contain an arbitrary constant α, whose meaning needs to be studied, eventually in relation to the concepts of quantification or gauge transformations. The two important values of the constant α are 1 (Hamilton's principle) and 1/2 (Maupertuis-Jacobi Least Action Principle).

6580 Mathematical Physics

REFER ALSO TO CITATION(S) 30700, 30701, 30726, 30824

30826 (CONF-8103167—1) Automorphism theorems and half-range theory. Kaper, H.G. (Argonne National Lab., IL (USA)). 1981. Contract W-31-109-ENG-38. 10p. NTIS, PC A02/MF A01. Order Number DE83010599.

From 7. international conference on transport theory; Lubbock, TX, USA (17 Mar 1981).

In the Hilbert space approach to the linear-transport equation (homogeneous slab configurations) the fundamental question of half-range theory concerns the existence of a bijective mapping of the underlying function space onto itself. In this article we discuss the existence and continuity properties of this mapping. We interpret the results in terms of conditions on the boundary data for half-space and finite slab boundary value problems.

30827 (ITEF—120(1981)) Functional equations, transformation groups and dynamical systems. Petukhov, V.R. (Gosudarstvennyj Komitet po Ispol'zovaniyu Atomnoj Ehnergii SSSR, Moscow. Inst. Teoreticheskoj i Ehksperimental'noj Fiziki). 1981. 12p. (In Russian). NTIS (US Sales Only), PC A02/MF A01. Order Number DE83700183.

The theoretical group analysis of invariant varieties of general dynamical systems is carried out. From this viewpoint some aspects of stability and, in particular, the existence of asymptotic phase are studied.

30828 (JINR—5-82-69) Existence in Rsup(n) of positive solution of Derechlet problem for one nonlinear elliptic equation. Zhidkov, P.E. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Computing Techniques and Automation). 1982. 15p. (In Russian). NTIS (US Sales Only), PC A02/MF A01. Order Number DE83700187.

Some problems of the existence of the solution of nonlinear elliptic equation $u-\Delta u=f(x, u)$ are studied. The results generalize the known theorems about the existence of a solution for the case of bounded domain. It is proved that the conditions needed for the solution in the bounded domain to exist and the condition lim f(x, u)=0 uniformly by any finite 'x'→infinity interval (a, b) for u endure the existence of the positive solution of the problem. An example is given which shows that the conditions for a solution in the bounded domain to exist are not sufficient for unbounded domain.

30829 Commutativity of products for adjoint operators. Agrawala, V.K. (Point Park Coll., Pittsburgh, PA). *Hadronic Journal;* 5: No. 5, 1632-1657(Aug 1982). (CONF-820136—).

From 1. international conference on non-potential interactions and their Lie-admissible treatment; Orleans, France (5 Jan 1982).

Let L deonote a finite dimensional semisimple Lie algebra over an arbitrary field of characteristic zero, and U = U(L) its universal enveloping algebra. Using the structure constants of L, one can define a vector product in the space Hom/sub L/(L,U) which makes it an associative algebra with identity. We prove here an earlier conjecture of Okubo and Myung that this algebra is commutative. We also define a scalar product which maps two elements of Hom/sub L/(L,U) into the center of U and show it to be commutative.

30830 Note on commutativity of adjoint operator algebras. Okubo, S. (Univ. of Rochester, NY); Myung, H.C. *Hadronic Journal;* 5: No. 5, 1658-1666(Aug 1982). (CONF-820136—). Contract AC02-76ER13065.

From 1. international conference on non-potential interactions and their Lie-admissible treatment; Orleans, France (5 Jan 1982).

V. Agrawala has recently proved our previous conjecture on communtativity of adjoint operator algebras for semisimple Lie algebras over a field of characteristic 0. In this note, we given an alternative proof of this conjecture which is considerably shorter than Agrawala's proof. Also, some other properties of adjoint operators are discussed for quasi-classical Lie algebras.

30831 Schroedinger equation for non-associative quantum mechanics and No-Go theorem. Okubo, S. (Univ. of Rochester, NY). *Hadronic Journal;* 5: No. 5, 1667-1700(Aug 1982). (CONF-820136—).

From 1. international conference on non-potential interactions and their Lie-admissible treatment; Orleans, France (5 Jan 1982).

Within an algebraic framework of non-associative quantum mechanics, a Hilbert space and the corresponding Schroedinger equation have been introduced into the theory as follows. The underlying non-associative operator algebra A is assumed to be flexible and Lie-admissible so that it is compatible with the Heisenberg equation of motion and quantization. A Hilbert space can be introduced into the theory as a faithful representation of the associated Lie algebra A^- of the Lie-admissible algebra A. However, if A^- is the standard Heisenberg algebra, and if the representation is irreducible, then it is shown that A must be associative, reproducing the standard associative quantum mechanics. Some discussions to circumvent this No-Go theorem are discussed. Especiallyyu if we are interested in the formulation of infinite component wave equations, then this difficulty can be avoided.

30832 Subspace decompositions invariant under ad/sub e/ for Lie-admissible algebras. Wene, G.P. (Univ. of Texas, San Antonio). *Hadronic Journal;* 5: No. 5, 1701-1716(Aug 1982). (CONF-820136—).

From 1. international conference on non-potential interactions and their Lie-admissible treatment; Orleans, France (5 Jan 1982).

Let A be a non-associative algebra of characteristic not two. It is known that the operator ad/sub x/ on A defined by ad/sub x/ (y) = [x,y] is a derivation of A^+ for all x if and only if A is flexible, and that A is Lie-admissible if and only if ad/sub x/ is a derivative of A^- for each x in A. Properties of a decomposition of A into subspaces invariant under ad/sub e/, e an idempotent element, are investigated. The very strong relations between the Peirce decomposition, the Lie-admissible condition and ad/sub e/, e an indempotent, are determined. Multiplicative relations among the subspaces of a are given.

30833 Extensions of Heisenberg's equations. Ilamed, Y. (Sorequ Nuclear Research Center, Yavne, Israel). *Hadronic Journal;* 5: No. 5, 1734-1737(Aug 1982). (CONF-820136—).

From 1. international conference on non-potential interactions and their Lie-admissible treatment; Orleans, France (5 Jan 1982).

In this note we present some natural extensions of the commutator that can be used for a generalization of Heisenberg's equations. An example of extension of the commutator xy-yx is p(x,y) = axbyc - aybxc, where a,b,c are noncommuting coefficients inserted between the variables. If tr denotes trace, then for this extension of the commutator the following inequalities are generally valid: trp(x,y) not equal to 0, trxp(x,y) not equal to 0, tryp(x,y) not equal to 0, trxp(y,z) not equal to trp(x,y)z; whereas for the commutator, p(x,y) = xy-yx, all these inequalities become identities. If a,b,c,x,y are elements of an associative algebra A, then the algebra A^*, whose elements are the same as those of A but with the new composition law x*y = axbyc - aybxc, is not a Lie algebra; whereas if the new composition law * is the commutator, then the algebra A^* is a Lie algebra. This note is a first attempt to write some extensions of the commutator that preserve the above mentioned properties of the commutator: trace zero, orthogonal to its arguments, associative and Lie-admissible.

30834 Interaction between conservative and gradient-like systems. Bruter, C.P. (Universite Paris, Creteil Cedex, France). *Hadronic Journal;* 5: No. 5, 1748-1753(Aug 1982). (CONF-820136—).

From 1. international conference on non-potential interactions and their Lie-admissible treatment; Orleans, France (5 Jan 1982).

This paper is devoted to the taxonomy of physical forces through recent mathematical results.

30835 Construction of the programmed motion. Mari, T.B. (Peoples' Friendship Univ., Moscow, USSR). *Hadronic Journal;* 5: No. 5, 1802-1811(Aug 1982). (CONF-820136—).

From 1. international conference on non-potential interactions and their Lie-admissible treatment; Orleans, France (5 Jan 1982).

The objective of this paper is to outline some problems of the programmed motion. The Erugin's method for the construction of the set of differential equations according to the prescribed integrals, which plays a crucial role in the development of such motions, is discussed. Possible modifications of the inverse problem of dynamics is pointed out. One of the modifications, such as the construction of the functional, which takes stationary value on the solution of the constructed equations, has been worked out in detail.

30836 Power-associative products on matrices. Benkart, G.M.; Osborn, J.M. (Univ. of Wisconsin, Madison). *Hadronic Journal;* 5: No. 5, 1859-1892(Aug 1982). (CONF-820136—).

From 1. international conference on non-potential interactions and their Lie-admissible treatment; Orleans, France (5 Jan 1982).

The main purpose of this work is to classify all power-associative products * that can be defined on the algebra A of n/sup x/ n matrices over a field F of characteristic not 2 or 3, satisfying the condition that x*y-y*x = xy-yx for all x,y ϵ A, where xy denotes the usual associative prouct in A. Such products * are automatically Lie-admissible, and it is shown that they are Jordan-admissible also. The motivation for this investigation comes from recent studies of the spin of a proton or neutron usig such products defined on the associative envelope of the spin 1/2 matrices. Included in the present paper are results showing how the classification of the products * on n/sup x/n matrices can be carried over to the associative envelope of spin s matrices for arbitrary s.

30837 General solution of the inverse problem of the calculus of variations. Tonti, E. (Universita di Trieste, Italy). *Hadronic Journal;* 5: No. 4, 1404-1450(Jun 1982). (CONF-820136—).

From 1. international conference on non-potential interactions and their Lie-admissible treatment; Orleans, France (5 Jan 1982).

Using the operator notation, we show that for every nonlinera problem there exists a variational formulation and, much more an infinity of them. The corresponding functionals are easily obtained. It follows that the requirement of the existence of a variational formulation for a given problem as a heuristic criterion to select admissible field equations, or equations of motion, or interactions, is to be abandoned.

30838 Symmetries and first integrals. Kobussen, J.A. (Eidgenossisch Institut fuer Reaktorforschung, Wuerenlingen, Switzerland). *Hadronic Journal;* 5: No. 4, 1451-1478(Jun 1982). (CONF-820136—).

From 1. international conference on non-potential interactions and their Lie-admissible treatment; Orleans, France (5 Jan 1982).

The partial differential equations for the vector field generating a symmetry transformation for a dynamical system described by a set of first-order ordinary differential equations is derived. Furthermore, a method for the explicit solution of these partial differential equations is discussed. This automatically leads to the first integrals of the system. It follows that the complete symmetry group is always infinitely dimensional and that the components of the vector feld generating the symmetry can be easily expressed in terms of arbitrary functions of the first integrals. This program has been worked out in full detail for the one-dimensional harmonic oscillator and for the n-dimensional linearly damped anisotropic oscillator. The results for the free particle and the one-dimensional oscillator are generalizations of results found in literature.

30839 Foundation of damped nonlinear schroedinger equations. Hasse, R.W. (Institut Laue-Langevin, Grenoble, Cedex, France); Albrecht, K. *Hadronic Journal;* 5: No. 4, 1479-1488(Jun 1982). (CONF-820136—).

From 1. international conference on non-potential interactions and their Lie-admissible treatment; Orleans, France (5 Jan 1982).

Coupled quantum systems are separated via coherent states or by time dependent perturbation theory to yield damped nonlinear Schroedinger equations.

30840 **Complex Schroedinger configuration plane and its relation to a classical and real two dimensional representation for one dimensional quantum theory.** Gilson, J.G. (Queen Mary Coll., London, England). *Hadronic Journal;* 5: No. 4, 1489-1516(Jun 1982). (CONF-820136—).

From 1. international conference on non-potential interactions and their Lie-admissible treatment; Orleans, France (5 Jan 1982).

It is indicated how a two dimensional alternative to one dimensional Schroedinger quantum theory is related to nonpotential Hamiltonian theory. The ability of this two dimensional alternative to generate classical electromagnetic and thermal images for the processes taking place on and off the real configuration axis, is explored. In particular, it is shown how the quantum potential is related to a deformation of the rest mass distribution over the two dimensional surface.

30841 **Reductive Lie-admissible algebras applied to H-spaces and connections.** Sagle, A.A. (Inst. for Basic Research, Cambridge, MA). *Hadronic Journal;* 5: No. 4, 1546-1563(Jun 1982). (CONF-820136—).

From 1. international conference on non-potential interactions and their Lie-admissible treatment; Orleans, France (5 Jan 1982).

An algebra A with multiplication xy is Lie-admissible if the vector space A with new multiplication $[x,y] = xy-yx$ is a Lie algebra; we denote this Lie algebra by A^-. Thus, an associative algebra is Lie-admissible but a Cayley algebra is not Lie-admissible. In this paper we show how Lie-admissible algebras arise from Lie groups and their application to differential geometry on Lie groups via the following theorem. Let A be an n-dimensional Lie-admissible algebra over the reals. Let G be a Lie group with multiplication function μ and with Lie algebra g which is isomorphic to A^-. Then there exiss a corrdinate system at the identify e in G which represents μ by a function $F:gxg \rightarrow g$ defined locally at the origin, such that the second derivative, F^2, at the origin defines on the vector space g the structure of a nonassociative algebra (g, F^2). Furthermore this algebra is isomorphic to A and $(g, F^2)^-$ is isomorphic to A^-. Thus roughly, any Lie-admissible algebra is isomorphic to an algebra obtained from a Lie algebra via a change of coordinates in the Lie group. Lie algebras arise by using canonical coordinates and the Campbell-Hausdorff formula. Applications of this show that any G-invariant psuedo-Riemannian connection on G is completely determined by a suitable Lie-admissible algebra. These results extend to H-spaces, reductive Lie-admissible algebras and connections on homogeneous H-spaces. Thus, alternative and other non-Lie-admissible algebras can be utilized.

30842 **Classification of flexible composition algebras, I.** Okubo, S. (Univ. of Rochester, NY). *Hadronic Journal;* 5: No. 4, 1564-1612(Jun 1982). (CONF-820136—).

From 1. international conference on non-potential interactions and their Lie-admissible treatment; Orleans, France (5 Jan 1982).

The following theorem has been proven. Let A be a finite-dimensional flexible composition algebra over a field F of characteristic not equal to 2, and not equal to 3. Then, A must be either a Hurwitz, or a para-Hurwitz, or a pseudo-octonion algebra. If the field F is of characteristic 2, then the dimension of a composition algebra is arbitrary in contrast to the standard dimensionality of 1, 2, 4, or 8. Finally, it is shown that any finite-dimensional flexible composition algebra over a field F of any characteristic is automatically a Malcev-admissible algebra.

30843 **Classification of flexible composition algebras, II.** Okubo, S. (Univ. of Rochester, NY). *Hadronic Journal;* 5: No. 4, 1613-1626(Jun 1982). (CONF-820136—).

From 1. international conference on non-potential interactions and their Lie-admissible treatment; Orleans, France (5 Jan 1982).

A classification of flexible composition algebras has been completed for the case of the field F being of characteristic 3. Together with the result proved in I, we find that any finite dimensional flexible composition algebra over a field F of characteristic not equal to 2 is either a Hurwitz, or a para-Hurwitz, or a pseudo-octonion algebra.

30844 **One-dimensional random walk with phase transition.** Percus, O.E.; Percus, J.K. (Courant Inst. of Mathematical Sciences, New York, NY). *SIAM (Society for Industrial and Applied Mathematics) Journal on Applied Mathematics;* 40: No. 3, 485-497(Jun 1981). Contract AC02-76ER03077.

We consider a random walk on a one-dimensional lattice. The walk is asymmetric but with different asymmetry on the right and left halves of the line. As the parameter space describing the two asymmetries is covered, several qualitatively different distributions result: limiting distribution, unimodal diffusion and bimodal diffusion. The corresponding parameter space phase boundaries are obtained, as well as the precise form of the distributions.

30845 **Extension of the Kibble-Slepian formula for hermite polynomials using boson operator methods.** Louck, J.D. (Los Alamos National Lab., NM). *Advances in Applied Mathematics;* 2: 239-249(1981).

The Kibble-Slepian formula expresses the exponential of a quadratic form $Q(x) = x/\text{sup } t/S(I + S)^{-1}x$, $S/\text{sup } t/ = S$, in n variables $x = \text{col}(x/\text{sub } 1/,...,x/\text{sub } n/)$ as a series of products of Hermite polynomials, thus generalizing Mehler's formula. This extension is restricted, however, to the case where the diagonal elements of the symmetric matrix S are all unity. We derive the general formula for an arbitrary symmetric matrix S, where I + S is positive definite, using techniques familar from the boson operator treatment of the harmonic oscillator in quantum mechanics.

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REFER ALSO TO CITATION(S) 30309, 30648, 30892, 30901, 30942

30846 **(CEA-R—5153) Study of thermal and suprathermal electron density fluctuations in a plasma Focus.** Jolas, Alain. (Paris-11 Univ., 91 - Orsay (France); CEA Centre d'Etudes de Limeil, 94 - Villeneuve-Saint-Georges (France)). Feb 1982. 283p. (In French). NTIS (US Sales Only), PC A13/MF A01. Order Number DE83700210.

Thesis.

Thomson scattering of ruby laser light is used to study electron density fluctuations in a plasma Focus. One measures frequency and wavenumber spectra as well as angular distribution of fluctuations at given wavenumber. During the implosion phase, plasma layers with different characteristics are evidenced: a dense plasma layer where density fluctuations are isotropic with a thermal level, and a tenuous plasma layer where fluctuations are clearly anisotropic with a suprathermal level. The suprathermal fluctuations are attributed to microscopic instabilities due to the large electrical current which flows in the transition zone where the magnetic field mixes into the plasma. Thermal fluctuation measurements allow the determination of electron density and electron and ion temperatures of the dense layer plasma. One compares the observed characteristics of spectral components of suprathermal fluctuations with various types of known micro-instabilities. Relying on a simplified shock wave model it is deduced an average electrical resistivity greater than the classical Spitzer relation by two order of magnitudes. The lower hybrid drift instability appears to be dominant at the beginning of the implosion phase.

30847 **(CLM-R—210) JETCAT: a programme for computerised tomography.** Williamson, J.H. (UKAEA Culham Lab., Abingdon). Sep 1981. 35p. NTIS (US Sales Only), PC A03/MF A01. Order Number DE83700211.

A new method of computerised tomography for efficient reconstruction from sparse data has been described by Williamson and Evans (Computerised Tomography for Sparse-Data Plasma Physics Experiments. CLM-P 656) and the Fortran programme JETCAT has been written to process the data, and for the interactive design of experimental assemblies to achieve optimal perform-

ance. This report, which should be read in conjunction with the programme listing attached, describes the overall structure of the programme, explains each subroutine, and specifies the input and the outputs that occur. The work was motivated by a design study for interferometry on the Joint European Torus (JET), but it can be applied to any other tomographic experiment with sparse data.

30848 **(CONF-830342—1) Equilibrium and stability studies for high-beta plasmas in torsatron/heliotron devices.** Carreras, B.A.; Charlton, L.A.; Cooper, W.A.; Garcia, L.; Harris, J.H.; Hender, T.C.; Hicks, H.R.; Holmes, J.A.; Lynch, V.E.; Masden, B.F. (Oak Ridge National Lab., TN (USA)). 1983. Contract W-7405-ENG-26. 13p. NTIS, PC A02/MF A01. Order Number DE83009857.

From US/Japan 3-D MHD workshop; Nagoya, Japan (8 Mar 1983).

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The equilibrium and stability properties of high-β plasmas in torsatron/heliotron devices have been investigated. Three numerical approaches have been used to study plasma equilibria for a range of coil configurations. The method of averaging permits fast equilibrium and stability calculations. Two fully 3-D codes, namely the Chodura-Schluter code, and the NEAR code recently developed at ORNL, are used to explore selected regions of parameter space. The resulting equilibria calculated with different methods are in good agreement. This validates the average method approach and enhances its usefulness. Results are presented for configurations with different aspect ratios and number of field periods. The role of the vertical field has also been studied in detail. The main conclusion is that for moderate aspect ratios (A/sub p/ $\leqq$ 8), the self-stabilizing effect of the magnetic-axis shift is large enough to open a direct path to the second-stability regime.

30849 **(DOE/ER/10603—3) Creation of high-temperature plasma through the use of a superfast Z-pinch.** Auslender, A.H. (Columbia Univ., New York (USA). School of Engineering and Applied Science). 1983. Contract AC02-80ER10613. 155p. NTIS, PC A08/MF A01. Order Number DE83011021.

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This thesis is a theoretical and computational study of plasma temperature generated during a superfast Z-pinch hydrogen plasma implosion-driven by a modern multi-terrawatt pulsed power source. The solution of the time-dependent, one-dimensional, initial-value problem used to study and describe the pinch process includes the effects of kinetic instabilities, anomalous collisionality, plasma heating, and all relevant energy-loss mechanisms. Two dimensional effects are estimated by using a modified form of the one-dimensional model.

30850 **(DOE/ER/53140—7) Monte Carlo studies of tandem mirror plasmas interacting with waves in the ion cyclotron range of frequencies (ICRF). Progress report, January 1, 1983-March 31, 1983.** Todd, A.M.M. (Grumman Aerospace Corp., Princeton, NJ (USA)). Mar 1983. Contract AC02-82ER53140. 43p. NTIS, PC A03/MF A01. Order Number DE83009573.

The recent emphasis of our Monte Carlo ICRF calculations for Tandem Mirrors has been in the area of model and code development. A Monte Carlo Charge Exchange model has been incorporated and tested, and several variance reduction techniques have been added. Since this has constituted a major revision of the code, we are still in the process of testing and revising these latter improvements.

30851 **(DOE/ET/51013—65) D-D fusion neutron-spectra measurements and ion-temperature determination at Alcator C.** Fisher, W.A. (Massachusetts Inst. of Tech., Cambridge (USA). Plasma Fusion Center). Feb 1983. Contract AC02-78ET51013. 186p. (PFC/RR—83-3). NTIS, PC A09/MF A01. Order Number DE83011020.

A neutron spectrometer system has been designed, assembled, and used to measure the D-D neutron spectrum at Alcator C. The design of the shielding and collimation was critical to the successful measurement of the spectrum and involved an integral approach in which the neutronics of the Alcator C was exploited to obtain a successful system. The system consists of a ^{3}He ionization chamber mounted in a multi-component shield system. Essentially the outermost part of the shield and collimator has been designed to moderate the MeV-range neutrons to thermal energies. The inner part of the shield is designed to capture the thermalized neutrons with a minimum of gamma production. As a result, measurements during plasma discharges indicate that the ratio of the number of counts in the 2.45-MeV peak to the total number of neutron counts in the ion chamber is 1.67.

30852 **(DOE/ET/51013—72) Stochasticity induced by coherent wavepackets.** Fuchs, V.; Krapchev, V.; Ram, A.; Bers, A. (Massachusetts Inst. of Tech., Cambridge (USA). Plasma Fusion Center). Feb 1983. Contract AC02-78ET51013. 8p. (PFC/CP—83-2; CONF-830210—14). NTIS, PC A02/MF A01. Order Number DE83010254.

From 5. topical conference on radio frequency plasma heating; Madison, WI, USA (21 Feb 1983).

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We consider the momentum transfer and diffusion of electrons periodically interacting with a coherent longitudinal wavepacket. Such a problem arises, for example, in lower-hybrid current drive. We establish the stochastic threshold, the stochastic region Δv/sub stoch/ in velocity space, the associated momentum transfer j, and the diffusion coefficient D. We concentrate principally on the weak-field regime, tau/sub autocorrelation/ $<$ tau/sub bounce/.

30853 **(DOE/ET/51013—73) Relativistic two-dimensional theory of rf current drive.** Hizanidis, K.; Krapchev, V.; Bers, A. (Massachusetts Inst. of Tech., Cambridge (USA). Plasma Fusion Center). Feb 1983. Contract AC02-78ET51013. 8p. (PFC/CP—83-3; CONF-830210—15). NTIS, PC A02/MF A01. Order Number DE83010250.

From 5. topical conference on radio frequency plasma heating; Madison, WI, USA (21 Feb 1983).

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The quasilinear theory of Fisch is extended to include relativistic effects, as well as dependence of the tail perpendicular temperature T/sub perpendicular to/ on the parallel momentum P/sub parallel/. The problem involves a two-dimensional Fokker-Planck equation describing the quasilinear relaxation due to the rf spectrum in the presence of collisions and with relativistic effects taken into account. The rf spectrum applies in the region $p_0 \leqq p \leqq p_1$ where p_0 and p_1 are the left and right matching moments which respectively connect the region under consideration to the thermal bulk (T/sub B/ $\approx$ 1 keV) and an outmost Maxwellian tail (T $\approx$ 1 keV).

30854 **(DOE/ET/53088—83) Non-intrinsic ambipolar diffusion in turbulence theory.** Berk, H.L.; Molvig, K. (Texas Univ., Austin (USA). Inst. for Fusion Studies; Massachusetts Inst. of Tech., Cambridge (USA)). Mar 1983. Contract FG05-80ET53088. 12p. (IFSR—83). NTIS, PC A02/MF A01. Order Number DE83010321.

Ambipolar flow in a turbulent plasma is investigated by combining a WKB treatment of the waves with a turbulent collision operator resulting from either quasi-linear theory or certain renormalized turbulence theories. If the wave momentum has a flow from outgoing waves, then particle diffusion is not intrinsically ambipolar, and the time variation of the electric-potential profile is determined by the turbulent spectrum. However, in most cases of practical interest, as in the drift-wave problem, this effect is small; and, in steady state, equal rates of stochastic diffusion are predicted for electrons and ions.

30855 **(DOE/ET/53088—87) Ballooning-mode calculations in stellarators.** Berk, H.L.; Rosenbluth, M.N.; Shohet, J.L. (Texas Univ., Austin (USA). Inst. for Fusion Studies). Mar 1983. Contract FG05-80ET53088. 19p. (IFSR—87). NTIS, PC A02/MF A01. Order Number DE83010322.

In this note we: (1) write the ballooning equations in a manner that is readily integrated by a field line following code; (2) analyze the asymptotic properties of the ballooning mode equation to rederive the Mercier condition in a form particularly well suited for our computations; and (3) evaluate the low beta stability properties for three typical configurations, Proto-Cleo, Wistor U and a

Heliac where the magnetic fields are due to actual vacuum coils plus the currents arising from a localized pressure gradient.

30856 **(EUR-CEA-FC—1139) Low-m magnetic modes activity and disruptions in Tokamaks discharges.** Cotsaftis, Michel. (Association Euratom-CEA, Centre d'Etudes Nucleaires de Fontenay-aux-Roses, 92 (France). Dept. de Recherches sur la Fusion Controlee). Jan 1982. 55p. NTIS (US Sales Only), PC A04/MF A01. Order Number DE83700213.

It has been possible to follow the evolution of the low-m modes and discuss the various patterns of their interactions. The structure of the non linear mode has been studied, and shown to possess a periodic time dependence which, on a rational magnetic surface where q = m/n, and large aspect ratio case, reduces to the sum of two pure oscillations with different frequencies. The amplitude of the mode has been evaluated, and it is further shown that, in the limit cycle regime, the modes amplitudes is small enough for them not to interact. This is not the case when the limit cycle becomes unstable, where the modes can now intermix by direct coupling or overlapping, and create a disruption. For this reason, stability criteria, both linear and nonlinear, respectively corresponding to the beginning and the end of the existence of the limit cycle, have been explicitely set down, showing the three domains corresponding to the three previous steps in an adapted parameter space. It is possible to follow the detailed evolution of the low-m modes all along the discharge duration. For regular enough profiles, the mode (m = 2, n = 1) is shown to largely dominate and, when becoming nonlinearly unstable, to drive the disruptions ending the discharges. In other words, in the present picture, the disruption is interpreted as the instability of a limit cycle rather than the usual linear instability of the zero amplitude mode, ie, corresponds to a second branching, and not to a first one.

30857 **(ITF—81-92-R) Radiation of non-uniform plasma column.** Gvozdetskij, V.S.; Zagorodnij, A.G.; Krivtsun, I.V.; Yakimenko, I.P. (AN Ukrainskoj SSR, Kiev. Inst. Teoreticheskoj Fiziki). 1981. 26p. (In Russian). NTIS (US Sales Only), PC A03/MF A01. Order Number DE83700220.

The solution of the problem of thermal radiation is obtained for the case of non-uniform plasma column approximated by an arbitrary number of uniform cylindrical layers. Plasma is described within the frame of hydrodynamic model with gas-kinetic pressure of electrons and dynamics of molecular sub-system taken into account. The power of radiation is calculated on the basis of Langevin approach by using the reciprocity theorem to solve the problem of fluctuation field excitation by by random sources.

30858 **(KFTI—81-37) Deposition probes for analysing the boundary plasma parameters in closed magnetic traps. Analytical review.** Vasil'ev, V.V.; Vojtsenya, V.S. (AN Ukrainskoj SSR, Kharkov. Fiziko-Tekhnicheskij Inst.). 1981. 58p. (In Russian). NTIS (US Sales Only), PC A04/MF A01. Order Number DE83700221.

Operating conditions and prospects of using deposition probes for studying near-wall plasma parameters are examined. The operational experience of this technique is generalized with taking into account the possibilities of existing surface analysis methods. On the basis of the near-wall plasma model for tokamak and the deposition probe model, the relation is indicated between the ion flux density to the probe and the impurity deposition profile, on the one hand, and plasma parameters in the shade of the limiter, on the other hand. Typical construction of deposition probes, examples of their particular application and the results obtained are presented; several special tasks which can be solved by means of the mentioned technique are discussed. The comparison is made between the deposition probe method and standard plasma diagnostics. From the undertaken analysis it follows that the method seems to be promising for studying different parameters of a plasma in the limiter shade region. In addition, the main methods of the analysis of sample surfaces exposed to a plasma in order to obtain its most important characteristics are discussed briefly.

30859 **(ORNL/TM—8530) Neutral beam heating in stellarators: a numerical approach.** Hokin, S.A.; Rome, J.A.; Hender, T.C.; Fowler, R.H. (Oak Ridge National Lab., TN (USA)). Mar 1983. Contract W-7405-ENG-26. 27p. NTIS, PC A03/MF A01. Order Number DE83010458.

Calculation of neutral beam deposition and heating in stellarators is complicated by the twisty stellarator geometry and by the usual beam focusing, divergence, and cross-sectional shape considerations. A new deposition code has been written that takes all of this geometry into account. A unique feature of this code is that it gives particle deposition in field-line coordinates, enabling the thermalization problem to be solved more efficiently.

30860 **(PPPL—1969) Nonlinear gyrokinetic equations.** Dubin, D.H.E.; Krommes, J.A.; Oberman, C.; Lee, W.W. (Princeton Univ., NJ (USA). Plasma Physics Lab.). Mar 1983. Contract AC02-76CH03073. 40p. NTIS, PC A03/MF A01. Order Number DE83010846.

Nonlinear gyrokinetic equations are derived from a systematic Hamiltonian theory. The derivation employs Lie transforms and a noncanonical perturbation theory first used by Littlejohn for the simpler problem of asymptotically small gyroradius. For definiteness, we emphasize the limit of electrostatic fluctuations in slab geometry; however, there is a straight-forward generalization to arbitrary field geometry and electromagnetic perturbations. An energy invariant for the nonlinear system is derived, and various of its limits are considered. The weak turbulence theory of the equations is examined. In particular, the wave kinetic equation of Galeev and Sagdeev is derived from an asystematic truncation of the equations, implying that this equation fails to consider all gyrokinetic effects. The equations are simplified for the case of small but finite gyroradius and put in a form suitable for efficient computer simulation. Although it is possible to derive the Terry-Horton and Hasegawa-Mima equations as limiting cases of our theory, several new nonlinear terms absent from conventional theories appear and are discussed.

30861 **(PPPL—1981) Efficient ion heating via finite-Larmor-radius ICRF.** Ono, M.; Wurden, G.A.; Wong, K.L. (Princeton Univ., NJ (USA). Plasma Physics Lab.). Mar 1983. Contract AC02-76CH03073. 15p. NTIS, PC A02/MF A01. Order Number DE83010842.

Ion heating by externally launched ion Bernstein waves is investigated in the ACT-1 hydrogen plasma. Detailed measurements of wave absorption and of the ion temperature profiles have clearly identified various heating layers near the ion cyclotron harmonics of deuterium-like and tritium-like ions. The observed heating of 10 eV/WATT/10^{10} cm^{-3} and the power-balance estimates suggest excellent overall efficiency for FLR-ICRF heating.

30862 **(PPPL—1984) Collisional diffusion in a torus with imperfect magnetic surfaces.** White, R.B. (Princeton Univ., NJ (USA). Plasma Physics Lab.). Mar 1983. Contract AC02-76CH03073. 28p. NTIS, PC A03/MF A01. Order Number DE83010844.

A Hamiltonian forumlation of the guiding-center drift equations is used to investigate the modification of neoclassical diffusion for low collisonality in a toroidal magnetic field with partially destroyed magnetic surfaces. The magnetic field is assumed to be given by the small perturbation of an axisymmetric system. The results are applicable to particle diffusion in realistic confinement systems, midway between axisymmetric and purely stochastic ones. Significant enhancement of electron diffusion over neoclassical rates is found. This increase can be accounted for by the contributions due to the first few island chains in the Fibonacci sequence generated by the zero-order islands, and by associated stochastic domains.

30863 **(PPPL—1991) Kinetic and resistive effects on interchange instabilities for a cylindrical model spheromak.** Hammett, G.W.; Tang, W.M. (Princeton Univ., NJ (USA). Plasma Physics Lab.). Apr 1983. Contract AC02-76CH03073. 28p. NTIS, PC A03/MF A01. Order Number DE83010837.

The stabilizing influence of diamagnetic drift effects on ideal and resistive interchange modes is investigated. A resistive-ballooning-mode equation is derived using a kinetic theory approach and is applied to a cylindrical model spheromak equilibrium. It is found that these kinetic effects can significantly improve the β limits for collisionless interchange stability. For the resistive modes, the diamagnetic drift terms lead to growth rates which scale linearly with resistivity and are considerably reduced in magnitude. However, the resistive interchange growth rates estimated for near-term spheromak parameters remain significant.

30864 **(PPPL—1992) Theory of mode-induced beam-particle loss in tokamaks.** White, R.B.; Goldston, R.J.; McGuire, K.; Boozer, A.H.; Monticello, D.A.; Park, W. (Princeton Univ., NJ (USA). Plasma Physics Lab.). Apr 1983. Contract AC02-76CH03073. 35p. NTIS, PC A03/MF A01. Order Number DE83010838.

Large-amplitude rotating magnetohydrodynamic modes have been observed to induce significant high-energy-beam particle loss during high-power perpendicular neutral-beam injection on PDX. A Hamiltonian formalism for drift-orbit trajectories in the presence of such modes is used to study induced particle loss analytically and numerically. Results are in good agreement with experiment.

30865 **(PPPL—1993) Fast-ion orbit effects during ion-cyclotron range of frequency experiments on the Princeton large torus.** Kaita, R.; Goldston, R.J.; Beiersdorfer, P.; Herndon, D.L.; Hosea, J.; Hwang, D.Q.; Jobes, F.; Meyerhofer, D.D.; Wilson, J.R. (Princeton Univ., NJ (USA). Plasma Physics Lab.). Apr 1983. Contract AC02-76CH03073. 16p. NTIS, PC A02/MF A01. Order Number DE83010840.

The angular dependence of the flux of fast neutrals was measured in conjunction with Ion Cyclotron Range of Frequency (ICRF) experiments on the Princeton Large Torus (PLT). We found a regime where the energetic tail of the charge-exchange neutral flux was strongly anisotropic. Unexpectedly, however, the flux from co-moving ions was peaked at an angle intermediate between perpendicular and parallel. This could be the consequence of a preferential filling of that class of banana orbits whose tips are localized within the ion cyclotron resonance layer.

30866 (UCRL—52000-83-2, pp 21-29) **Neutron diagnostics for magnetically confined plasmas.** Feb 1983. NTIS, PC A03/MF A01.

In Energy and Technology Review.

Spectrometers were developed for measuring neutrons emitted by hot plasmas, enabling one to obtain information on mean ion energies and other parameters of interest in magnetic fusion experiments.

30867 **(UCRL—88568) Power deposition profiles in Maxwellian magneto-active plasmas.** Ziolkowski, R.W.; Peterson, J.C. (Lawrence Livermore National Lab., CA (USA)). Feb 1983. 6p. (CONF-830210—10). NTIS MF A01. Order Number DE83009321.

From 5. topical conference on radio frequency plasma heating; Madison, WI, USA (21 Feb 1983).

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The numerical modeling of the microwave power deposition in a plasma for waves that are launched from an arbitrary array of pyramidal horns will be described. The waves are modeled in three dimensions with geometrical optics assuming the plasma is cold, magneto-active and Maxwellian. The power absorption at the fundamental harmonic is calculated along those rays with warm plasma absorption formulas. A newly developed post-processor synthesizes power deposition profiles from these ray tracing results. Graphical output includes the power density as a function of the distance along the axis of the plasma and the physical or midplane radius, the z-integrated power density as a function of the midplane radius, and the cumulative power absorbed as a function of the midplane radius. Examples for ECRH in the TMX-U and the axisymmetric MFTF-B tandem mirror machines at LLNL will be presented.

30868 **Three-dimensional theory of waveguide-plasma coupling.** Bers, A.; Theilhaber, K.S. (Massachusetts Inst. of Tech., Cambridge (USA). Plasma Fusion Center). *Nuclear Fusion;* 23: No. 1, 41-48(Jan 1983).

A general, linear theory of coupling electromagnetic fields from free-space waveguide arrays to an inhomogeneous plasma in a magnetic field is presented. In contrast to previous analyses, which assumed parallel-plate waveguides, waveguides having closed cross-sections of arbitrary shape are considered; full account is taken of all the waveguide modes. Far away from the coupling region, the plasma is assumed to be absorptive and the waveguides to propagate only their dominant modes. The formulation is geared to obtain the reflection coefficients in the waveguides and the excitation of waves in the plasma. The results are applicable to RF heating of plasmas whose size is large compared to the waveguide array, as would be the case in a fusion reactor, and valid for the frequency regimes of either ion-cyclotron (harmonic), or lower-hybrid, or electron-cyclotron (harmonic) heating.

30869 **Heating experiments in the ion cyclotron range of frequencies on EBT-S.** Owens, T.L.; Mullen, J.H. (McDonnell Douglas Corp., St. Louis, MO (USA)); Baity, F.W.; Davis, W.A.; Eldridge, O.C.; Hillis, D.L. (Oak Ridge National Lab., TN (USA)). *Nuclear Fusion;* 23: No. 1, 49-62(Jan 1983).

Heating experiments in EBT-S have been conducted in steady-state plasmas at continuous wave power levels up to 20 kW in the ion cyclotron range of frequencies (15-30 MHz). Power coupling efficiencies and wave propagation measurements have been obtained at reduced power levels over the frequency range 15-50 MHz. Wave dispersion properties are in qualitative agreement with simplified theory. Substantial ion heating is obtained in deuterium plasmas above 25 MHz, the point at which wave propagation begins. At this frequency, only the 3rd-10th ion cyclotron harmonics of deuterium are present in the core plasma. Ion heating under these circumstances is considerably greater than theoretically predicted for EBT-S parameters. A residual proton component is also heated. However, collisional energy transfer from the protons to the deuterons is too small to account for the deuteron heating. The stored energy of the relativistic electron annuli increases substantially with the application of wave power. Near the antenna, the stored energy more than doubles at a power level of 15 kW. The mechanism producing this dramatic effect is not well understood at present. A small reduction in the ambipolar electric field is also observed during wave heating.

30870 **Scaling of energy confinement with minor radius, current and density in Doublet III Ohmically heated plasmas.** Ejima, S.; Petrie, T.W.; Riviere, A.C. (General Atomic Co., San Diego, CA (USA)). *Nuclear Fusion;* 22: No. 12, 1627-1649(Dec 1982).

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The dependence of plasma energy confinement on minor radius, density and plasma current is described for Ohmically heated near-circular plasmas in Doublet III. A wide range of parameters is used for the study of scaling laws; the plasma minor radius defined by the flux surface in contact with limiter is varied by a factor of 2 (a = 44, 32, and 23 cm), the line average plasma density, nsub(e)-bar, is varied by a factor of 20 from 0.5 to 10 x 10^{13} cm^{-3} (nsub(e)-bar R_o/Bsub(T) = 0.3 to 6 x 10^{14} $cm^{-2}.kG^{-1}$) and the plasma current, I, is varied by a factor of 6 from 120 to 718 kA. The range of the limiter safety factor, qsub(L), is from 2 to 12. - For plasmas with a = 23 and 32 cm, the scaling law at low nsub(e)-bar for the gross electron energy confinement time can be written as (s, cm) tausub(Ee)sup(G) approx.= 3.6 x 10^{-19} nsub(e)-bar a^2 qsub(c)sup(3/4), where qsub(c) = $2\pi a^2$Bsub(T)/μ_oIR_o. For the 44-cm plasmas, tausub(Ee)sup(G) is about 1.8 times less than predicted by this scaling, possibly owing to the change in limiter configuration and small plasma-wall separation and/or the aspect ratio change. At high nsub(e)-bar, tausub(Ee)sup(G) saturates and in many cases decreases with nsub(e)-bar but increases with I in a classical-like manner. The dependence of tausub(Ee)sup(G) on a is considerably weakened. The confinement behaviour can be explained by taking an ion thermal conductivity 2 to 7 times that given by Hinton-Hazeltine's neoclassical theory with a lumped-

Zsub(eff) impurity model. Within this range the enhancement factor increases with a or a/R_0. The electron thermal conductivity evaluated at half-temperature radius where most of the thermal insulation occurs sharply increases with average current density within that radius, but does not depend on a within the uncertainties of the measurements.

30871 **Zero-dimensional simulations of reversed-field pinch experiments.** Schoenberg, K.F.; Gribble, R.F.; Phillips, J.A. (Los Alamos National Lab., NM (USA)). *Nuclear Fusion;* **22**: No. 11, 1433-1441(Nov 1982).

A zero-dimensional (0-D) simulation of a Reversed-Field Pinch (RFP) experiment is presented. Plasma behaviour is addressed by a model that couples the toroidal and poloidal RFP magnetic fields in a prescribed, non-linear manner. The simulation is used to study pinch parameters such as magnetic field energy, power loss, plasma resistance and resistivity, and conductivity temperature as functions of time. The methodology of the 0-D simulation, its sensitivity to model-dependent effects, and application examples from the Los Alamos ZT-40M RFP experiment are given.

30872 **Effect of plasma current on restoring force in Ohmically heated stellarators.** Yamagishi, T. (General Atomic Co., San Diego, CA (USA)). *Nuclear Fusion;* **22**: No. 11, 1525-1528(Nov 1982).

Letter-to-the-editor.

In Ohmically heated stellarators the diamagnetic effect of a plasma current on the effective vertical magnetic field induced by a toroidal shift of the plasma column in the helical magnetic field is studied. The theoretical result agrees well with the experimental data from the JIPP T-II stellarator.

30873 **Effect of gas recycling and secondary electron emission on the axial power flow in an open-ended device.** Porter, G.D. (California Univ., Livermore (USA). Lawrence Livermore National Lab.). *Nuclear Fusion;* **22**: No. 10, 1279-1289(Oct 1982).

A model analyses the effect of secondary electron emission and gas recycling on open-ended fusion devices. Secondary emission is assumed to be limited by space-charge effects. It is also assumed that cold plasma is created by the ionization of gas recycled from the end wall. The axial power flow in the device was increased by these phenomena. This article shows that fairly simple techniques can control the enhancement of the power losses. The results of this model are in agreement with measurements made on the TMX experiment. Estimates made for the TMX Upgrade and MFTF-B indicate that these effects will not significantly enhance the axial power losses.

30874 **End-wall plasma characteristics in the tandem mirror experiment.** Coakley, P.; Hershkowitz, N. (Iowa Univ., Iowa City (USA)); Porter, G.D. (California Univ., Livermore (USA). Lawrence Livermore National Lab.). *Nuclear Fusion;* **22**: No. 10, 1321-1327(Oct 1982).

An array of emitting and collecting probes was used to measure the characteristics of the plasma at the end wall of TMX. The emitting probes indicated a plasma potential with a characteristic value of approximately 8 V, measured at 2 cm and 10 cm from the grounded wall. The potential in the plug varied from 300 to 1000 V. The collecting probes indicated a cold plasma present near the wall, with an electron temperature of about 5 eV and a cold-electron density of about 2×10^9 cm^{-3}, while the hot-ion density at the wall was about 6×10^8 cm^{-3}. The density of electrons in the plug was about 2×10^{12} cm^{-3}. The electron temperature measured at the wall was decoupled from the temperature of the electrons in the plug and the central cell. The plasma wall sheath was established to balance the flux of hot ions and cold electrons. An additional species of electrons, i.e. secondary electrons produced at the end wall, was also identified. These secondary electrons had a directed energy comparable to the local plasma potential, an energy spread of less than 7 eV, and a density of about 4×10^8 cm^{-3}. The experimental results are shown to be consistent with a simple model involving cold-gas recycling from the end wall.

30875 **Inductive energy extraction from a plasma.** Auerbach, S.P. (California Univ., Livermore (USA). Lawrence Livermore National Lab.). *Nuclear Fusion;* **22**: No. 10, 1329-1339(Oct 1982).

Efficient operation of a moving-ring reactor requires inductive energy extraction from the plasma after the thermonuclear burn is complete. The process of inductive energy extraction from a plasma is studied in this paper. An energy conservation theorem is proven, whose content is that the amount of energy which may be extracted inductively from a plasma is the sum of three terms: the self-inductance energy of the plasma, the energy associated with the mutual inductance between the plasma and the external field coils, and the plasma thermal energy. These terms are evaluated for a spherical Hill's vortex equilibrium. For this equilibrium, the sum of the first two terms is negative, i.e. for fixed external field the magnetic energy is lower when the plasma is present than when it is absent. This surprising fact is discussed and shown not to lead to any unphysical consequences. A careful analysis of a conceptual energy extraction device is given, with emphasis on the role of inductive interactions between the plasma and the external coils.

30876 **Is fusion reactivity in TFTR affected by distortions of the bulk ions from Maxwellians.** Mirin, A.A.; Tomaschke, G.P. (California Univ., Livermore (USA). Lawrence Livermore National Lab.). *Nuclear Fusion;* **22**: No. 10, 1380-1382(Oct 1982).

Letter-to-the-editor.

It is known that during the heating of a warm-background ion species by a more energetic ion species, the warm-ion distribution function departs from that of a Maxwellian. It is also known that the velocity dependence of the particle and energy loss mechanisms is a crucial factor in determining the manner in which the bulk ions deviate from Maxwellians. The question of the extent to which these distortions cause an enhanced fusion reactivity in a TFTR-like plasma is addressed. For the cases presented here, no enhancement is found.

30877 **ICRF heating, particle transport and fluctuations in tokamaks.** Taylor, R.J.; Lee, P.; Luhmann, N.C. Jr. (California Univ., Los Angeles (USA)). pp 61-72 of Plasma physics and controlled nuclear fusion research 1980. Proceedings of the eighth international conference held by the IAEA in Brussels, 1-10 July 1980. Vienna, Austria; International Atomic Energy Agency (1981).

From 8. international conference on plasma physics and controlled nuclear fusion research; Brussels, Belgium (1 Jul 1980).

The paper consists of three parts. Part A reports the results of ICRF heating at power levels up to five times Ohmic heating. The ions were heated from 50 to 200eV while the electron temperature increased from 150 to 250eV under optimum conditions. Impurity generation is controlled by Ti or Cr in-situ vapour deposition of about 100A thick. Heating is observed to vanish as the plasma density is raised above 10^{13}cm^{-3} in Macrotor and 10^{14}cm^{-3} in Microtor. Below these densities and at high power levels, the plasma particle confinement time, and consequently the energy confinement, diminishes with power input. Density clamping, drop or rise are produced depending on wall conditions. Part B describes magnetic field fluctuation measurements on the Caltech research tokamak. At low frequencies, $f<100$kHz, the approximately B spectrum is dominated by an $m=2$ or 3 mode and its harmonics, while at high frequencies, $100\text{kHz}<f<1\text{MHz}$, the approximately B fluctuations are broadband and have short correlation lengths. Part C reports on FIR scattering measurements of density fluctuations in the Microtor tokamak. The fluctuations exhibit a power law falloff of ωsup(-2.5) between 100kHz and 500kHz and ksup(-3.5) for 6cm^{-1} approximately $<$ k approximately $<$ 20cm^{-1}. A comparison of these measurements with theoretical models and with transport is presented.

30878 Fast-wave ion cyclotron heating in the Princeton Large Torus. Hosea, J.; Boyd, D.; Bretz, N. (Princeton Univ., NJ (USA). Plasma Physics Lab.). pp 95-103 of Plasma physics and controlled nuclear fusion research 1980. Proceedings of the eighth international conference held by the IAEA in Brussels, 1-10 July 1980. Vienna, Austria; International Atomic Energy Agency (1981).

From 8. international conference on plasma physics and controlled nuclear fusion research; Brussels, Belgium (1 Jul 1980).

Recent experimental results for ICRF heating in PLT are presented. For the two-ion regime in D-H or D-^{3}He plasmas minority H and ^{3}He ions are found to absorb the RF power and transfer it to the deuterons and electrons in accordance with Fokker-Planck theory. The deuteron heating rate is approximately $3eV x 10^{13} cm^{-3}.kW$ for H and approximately $6eV x 10^{13} cm^{-3}.kW$ for ^{3}He minorities. Neutron fluxes of approximately $3x10^{11} s^{-1}$ corresponding to a Tsub(d) approximately 2keV (ΔTsub(d) approximately 1.2keV) have been produced with Psub(RF) approximately 620kW at anti nsub(e) approximately $2.9x10^{13} cm^{-3}$. Neutron energy spectra and mass-sensitive charge-exchange spectra indicate Maxwellian deuteron distributions. In addition, D-^{3}He fusion reaction rates approximately $>10^{12} s^{-1}$ have been produced by the energetic ^{3}He ions. For the second-harmonic regime, initial heating results for an H plasma at Psub(RF) approximately 140kW are consistent with the Fokker-Planck theory, and the bulk heating rate is comparable with that of D-heating in the D-H minority regime.

30879 Initial reversed-field pinch experiments on ZT-40 and recent advances in RFP theory. Baker, D.A.; Buchenauer, C.J.; Burkhardt, L.C. (Los Alamos Scientific Lab., NM (USA)). pp 291-300 of Plasma physics and controlled nuclear fusion research 1980. Proceedings of the eighth international conference held by the IAEA in Brussels, 1-10 July 1980. Vienna, Austria; International Atomic Energy Agency (1981).

From 8. international conference on plasma physics and controlled nuclear fusion research; Brussels, Belgium (1 Jul 1980).

The ZT-40 reversed-field pinch (RFP) has been operated in several modes: (1) without reversed toroidal field, (2) with self reversal, and (3) with aided reversal. In the RFP mode, with fill pressures below 15mtorr, current decay times are significantly lengthened over non-reversed-field operation. Temperatures have been obtained up to approximately 70eV at peak current, well above the troublesome O VI radiation barrier. Quiet periods, approximately 0.1ms, have been observed in magnetic field and plasma density fluctuations. Recent operation with a power crowbar overcomes external circuit losses, which limit current decay times to approximately 0.3ms with a passive crowbar. An analytic Ohmic heating and ignition model confirms and provides guidance for transport codes. Non-dissipative formation schemes have been analysed and ideal MHD-stable evolution and burn scenarios have been found. Particle and fluid simulations have produced qualitative agreement with respect to the non-linear behaviour of m=0 resistive g-modes. Helical Ohmic reversed-field states are produced by a 2-D dynamical simulation, and non-linear analytic work describes the final state. A fast resistive MHD code for linear stability has clarified the relations between several kinds of resistive instablities. Ballooning modes and g-modes in systems with arbitrary magnetic shear, including resistivity and viscosity, have been studied in a unified treatment with growth rate versus wavenumber showing the existence of important cutoffs. Finally, work on auxiliary heating for profile control is in progress with a guiding-centre code and a more complete model containing gyroresonant effects.

30880 High-beta tokamak stability studies. Chu, C.K.; Elkin, D.; Georgiou, G. (Columbia Univ., New York (USA). Plasma Physics Lab.). pp 339-346 of Plasma physics and controlled nuclear fusion research 1980. Proceedings of the eighth international conference held by the IAEA in Brussels, 1-10 July 1980. Vienna, Austria; International Atomic Energy Agency (1981).

From 8. international conference on plasma physics and controlled nuclear fusion research; Brussels, Belgium (1 Jul 1980).

Recent experimental and theoretical research at Columbia University on MHD stability limits of tokamaks is summarized. Data obtained from Torus II indicate that it can operate in the second, high-beta stable regime with $\beta(0)$ approximately 30%, average value of β) approximately 10%, nsub(e)(0) approximately $3x10^{21} m^{-3}$ and T approximately 100eV. As the plasma cools, density fluctuations characteristic of a ballooning instability are observed. Simulations are compared with experimental observations. Theoretical results for ballooning and kink-mode instabilities are described.

30881 Reactor systems studies of alternative fusion concepts. Krakowski, R.A.; Miller, R.L.; Bathke, C.G. (Los Alamos Scientific Lab., NM (USA)). pp 607-619 of Plasma physics and controlled nuclear fusion research 1980. Proceedings of the eighth international conference held by the IAEA in Brussels, 1-10 July 1980. Vienna, Austria; International Atomic Energy Agency (1981).

From 8. international conference on plasma physics and controlled nuclear fusion research; Brussels, Belgium (1 Jul 1980).

The results from recent systems studies of seven alternative fusion reactor concepts are presented.

30882 Charge-exchange pumping of thermalized alpha particles in steady-state tandem-mirror reactors. Hamilton, G.W.; Logan, B.G. (Lawrence Livermore National Lab., CA). *Comments on Plasma Physics and Controlled Fusion;* **6**: No. 4, 139-145(1981). Contract W-7405-ENG-48.

Thermal alpha particles can be removed from tandem-mirror reactors (TMR) by charge-exchange on neutral beams injected into the potential wells of thermal barriers. This alpha-removal method has the advantage that 3.5-MeV alphas, magnetically trapped in the central cell, will not be removed until they have transferred almost all their energy to the reacting plasma, which facilitates ignition in the central cell. Under steady-state conditions the thermalized alpha particles will constitute 4% to 10% of the plasma density in a TMR.

30883 Null ellipticity in magneto-optics. O'Connell, R.F.; Wallace, G. (Louisiana State Univ., Baton Rouge). *Solid State Communications;* **39**: 993-995(1981). Contract AS05-79ER10459.

We determine the relationship between the photon, cyclotron, collision and plasma frequencies which ensures a null ellipticity for electromagnetic wave propagation in a free-carrier magnetoplasma. A comparison is made with the condition for null Faraday rotation.

7002 Fusion Power Plant Technology

REFER ALSO TO CITATION(S) 29893, 30016, 30314, 30848, 30870

30884 (AECL—7424) Fissile fuel breeding in DT fusion reactor blankets. Kushneriuk, S.A.; Wong, P.Y. (Atomic Energy of Canada Ltd., Chalk River, Ontario. Chalk River Nuclear Labs.). Nov 1981. 59p. NTIS (US Sales Only), PC A04/MF A01. Order Number DE83700209.

Results of neutronic evaluations of fissile fuel breeding in a variety of DT fusion hybrid-reactor blankets are presented. The blankets are of the fast-fission or fission-suppressed rather than fission-enhanced designs, i.e. in the blankets considered emphasis is on fissile fuel rather than power production. For ^{233}U breeding, when Li metal is the coolant for the first wall and the graphite moderator and the tritium breeding constituent of the blanket, the number of atoms of ^{233}U produced per fusion in blankets that could be of practical interest is in the range 0.5 - 0.68, with the lower value applying to water-cooled ThO_2 fertile fuel, the upper to gas-cooled Th-metal fuel located next to the reactor first wall. Neutron multipliers like Pb or Be can increase the production to about 0.74. For ^{239}Pu breeding, the production ratio in practical blankets is 0.6 - 1.64, with the best results being for gas, Na- or Li-metal-cooled U-metal fuels located adjacent to the first wall (the U is depleted uranium). Gas-cooled U-Th-metal blankets, optimized for ^{233}U breeding, yield 0.76 atoms of ^{233}U and 0.38 atoms of ^{239}Pu. The blanket energy multiplication factors are in the range 1.6 - 2.5 for Th blankets, 2.5 - 9.0 for U blankets and approximately 5.5 for the U-Th-metal blanket. The tritium breeding ratio in all blankets is 1.075. Blankets with other first wall, coolant and tritium breeding con-

stituents are also considered. The fusion power requirements of hybrids that could supply the fuel needs of thorium-burning CANDU power reactors, and the allowed costs for building the hybrids are indicated.

30885 **(ANL/FPP/TM—167) Irradiation and compatibility testing of Li_2O materials at EBR-II.** Porter, D.L.; Krsul, J.R.; Laug, M.T.; Tetenbaum, M.; Walters, L.C. (Argonne National Lab., IL (USA)). Dec 1982. Contract W-31-109-ENG-38. 53p. NTIS, PC A04/MF A01. Order Number DE83010691.

A study was made of the neutron-irradiation behavior of ^{6}Li-enriched Li_2O material in EBR-II. In addition, a stress corrosion study was performed ex-reactor to test compatibility of Li_2O materials with a variety of stainless steels. Results of the irradiation testing showed that tritium and helium retention in the Li_2O (~ 89% dense) lessened with neutron exposure. Helium tritium retention appeared to approach steady-state after ~ 1% ^{6}Li burnup. The effect was likely caused by the formation of open porosity in the pellets. The stress corrosion studies, using a 316 stainless steel (Ti-modified) and a 35% Ni alloy, showed that stress does not enhance the corrosion, and that dry Li_2O is not significantly corrosive, the LiOH content producing the corrosive effects. Corrosion, in general, was not severe as a passivation in sealed capsules seemed to occur after a time greatly reducing corrosion rates.

30886 **(CLM-R—219) Introduction to hybrid fusion.** Reynolds, J.A. (UKAEA Culham Lab., Abingdon). Jan 1982. 6p. NTIS (US Sales Only), PC A02/MF A01. Order Number DE83700212.

This report gives a brief introduction to some hybrid fusion proposals. The idea is to take advantage of the high neutron energy in fusion compared to fission either to breed fuel more efficiently than in a fast reactor, or increase the power output by fission of U^{238} or transmute radioactive waste. The penalty is an increased cost and complexity of the blanket and the loss of environmental and safety arguments for fusion systems which rest on their low inventory of radioactive materials.

30887 **(CONF-810804—26) Isotopic enrichment of fuels for D-T fusion reactors.** Misra, B.; Clemmer, R.G.; Finn, P.A. (Argonne National Lab., IL (USA)). 1981. Contract W-31-109-ENG-38. 8p. NTIS, PC A02/MF A01. Order Number DE83009033.

From National heat transfer conference; Milwaukee, WI, USA (2 Aug 1981).

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Isotopic enrichment scenarios using cryogenic distillation were developed for a near-term D-T burning fusion-reactor design (ETF) as well as for a commercial fusion-reactor design (STARFIRE). The analytical results of studies of spent-fuel reprocessing for ETF show that isotopic enrichment can be carried out to meet fuel-purity requirements by a system consisting of a 5-column distillation cascade and two chemical equilibrators. For STARFIRE, the analytical results show that, for a fixed number of columns and chemical equilibrators in a reprocessing syste, the compositions of the recycle streams depend strongly on whether the two fuel streams (plasma exhaust and blanket) are processed separately or mixed and then processed as a single stream.

30888 **(CONF-830406—6) Engineering testing requirements in FED/INTOR.** Abdou, M.A.; Nygren, R.E.; Morgan, G.D.; Trachsel, C.A.; Wire, G.; Oppermann, E.; Puigh, R.; Gold, R.E. (Argonne National Lab., IL (USA); McDonnell Douglas Astronautics Co., St. Louis, MO (USA); Hanford Engineering Development Lab., Richland, WA (USA); Westinghouse Research Labs., Pittsburgh, PA (USA)). Oct 1982. Contract W-31-109-ENG-38. 3p. NTIS, PC A02/MF A01. Order Number DE83009589.

From 5. topical meeting on technology of fusion energy; Knoxville, TN, USA (26 Apr 1983).

The FED/INTOR critical issues activity has addressed three key testing requirements that have the largest impact on the design, operation and cost of FED/INTOR. These are: (1) the total testing time (fluence) during the device lifetime, (2) the minimum number of back-to-back cycles, and (3) the neutron wall load (power density in the first wall/blanket). The testing program activities were structured into three tasks in order to define the benefits, and in some cases, costs and risks of these testing requirements. The three tasks were carried out with wide participation of experts from a number of organizations in the United States. Similar effort was performed by Japan, the European Community and the Soviet Union.

30889 **(CONF-830406—10) Key issues of FED/INTOR impurity control system.** Abdou, M.A. (Argonne National Lab., IL (USA)). Oct 1982. Contract W-31-109-ENG-38. 3p. NTIS, PC A02/MF A01. Order Number DE83009595.

From 5. topical meeting on technology of fusion energy; Knoxville, TN, USA (26 Apr 1983).

A key part of the FED/INTOR activity over the past year has focused on examining the critical issues and developing credible physics and engineering solutions for the impurity control system. The primary emphasis of the work was on the edge-region physics, plasma-wall interaction, materials, engineering and magnetic considerations of the poloidal divertor and pump limiter.

30890 **(CONF-830406—22) Waste management of first wall and blanket structural materials for tokamak fusion reactors.** Vogler, S.; Steindler, M.J.; Jung, J. (Argonne National Lab., IL (USA)). 1983. Contract W-31-109-ENG-38. 5p. NTIS, PC A02/MF A01. Order Number DE83010770.

From 5. topical meeting on technology of fusion energy; Knoxville, TN, USA (26 Apr 1983).

A comparison has been made of the induced radioactivities in the first wall and structural materials of the breeder blanket in the high-flux region for two different fusion-reactor types. One system is the STARFIRE, a tokamak reactor with PCA, a modified stainless steel, as a first wall and a $LiAlO_2$ breeder blanket; the other is a reactor based on the STARFIRE design with a vanadium alloy as the first wall and structural material, and circulating molten lithium as the breeder/coolant. The recycling or disposal of these structural materials is evaluated.

30891 **(DOE/DP/40168—1) ArF short-pulse extraction studies. Final technical report, 18 September 1981-18 February 1983.** Mandl, A. (Avco-Everett Research Lab., Inc., Everett, MA (USA)). Feb 1983. Contract AC08-81DP40168. 45p. NTIS, PC A03/MF A01. Order Number DE83011125.

The experimental apparatus including e-beam pulse diagnostics is discussed. The relative fluorescence and laser output for various gas mixtures is presented and the significant improvement in laser performance for Ne buffered mixtures, allowing scaling to high pressures and high Joules per liter, is discussed. The energy deposition measurements for Ar and Ne buffered mixtures are presented. Accurate deposition measurements are necessary for a meaningful measure of the laser output efficiency. Background absorption measurements important for accessing the scalability of the ArF system are presented. The sidelight suppression experiments are discussed and the laser efficiency measurements are shown. Finally, a discussion of the measurements with their implications for the ArF system is presented in the concluding section.

30892 **(DOE/ET/51013—71) Antenna-plasma coupling theory for ICRF heating.** Ram, A.; Bers, A. (Massachusetts Inst. of Tech., Cambridge (USA). Plasma Fusion Center). Feb 1983. Contract AC02-78ET51013. 8p. (PFC/CP—83-1; CONF-830210—17). NTIS, PC A02/MF A01. Order Number DE83010253.

From 5. topical conference on radio frequency plasma heating; Madison, WI, USA (21 Feb 1983).

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An analytical and numerical study of the antenna-plasma coupling theory in the slab geometry is presented. We model the antenna to be a current sheet of finite poloidal and toroidal dimensions which is screened from the plasma by a sheath of anisotropic conductivity that shorts out locally the toroidal component of the rf field. The effect of the feed lines that carry the current to the antenna is ignored. The plasma is described by its cold dielectric tensor having an inhomogeneous density and applied magnetic field. The density at the sheath is assumed to be large enough to

allow us to consider the excitation of only the fast component of the ICRF wave. The radiation impedance of, and the field excitation by, such an antenna structure are calculated. The analytical analysis is carried out when we ignore the explicit spatial derivatives of the plasma dielectric tensor elements that occur in the equations describing the plasma fields.

30893 **(DOE/ET/51013—74) Numerical investigation of ICRF antenna designs and heating schemes for Alcator C.** Blackfield, D.T.; Blackwell, B.D. (Massachusetts Inst. of Tech., Cambridge (USA). Plasma Fusion Center). Feb 1983. Contract AC02-78ET51013. 7p. (PFC/CP—83-4; CONF-830210—16). NTIS, PC A02/MF A01. Order Number DE83010246.

From 5. topical conference on radio frequency plasma heating; Madison, WI, USA (21 Feb 1983).

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Initially, approximately 500 kW of rf power will be launched through one port of Alcator C at a frequency of 180 to 220 MHz. We use a hot-plasma slab model to examine antenna coupling and power deposition for second harmonic (H, B_0 = 6.7 T) heating regime. The plasma medium is assumed uniform in y and z and is stratified in x. Three-dimensional, four-mode field solutions are obtained by solution of the boundary condition equations in the x direction, and by Fourier transform methods in y and z. We study the dependence of radiation resistance upon coupling parameters such as antenna width and radial position. This is interpreted in terms of the spectral (k/sub y/, k/sub z/) distribution of power, the effect of the evanescent region at the edge, and the attenuation length of the waves.

30894 **(DOE/ET/51013—75) Effect of wall corrugations on lower-hybrid-wave launching and reflection.** Schuss, J.J.; Porkolab, M. (Massachusetts Inst. of Tech., Cambridge (USA). Plasma Fusion Center). Feb 1983. Contract AC02-78ET51013. 7p. (PFC/CP—83-5; CONF-830210—13). NTIS, PC A02/MF A01. Order Number DE83010247.

From 5. topical conference on radio frequency plasma heating; Madison, WI, USA (21 Feb 1983).

The effect of wall corrugations on lower-hybrid-wave launching and reflection is considered and applied to the Alcator C 4.6-GHz RF experiment. A method of treating the effect of wall corrugations on wave launching is outlined. Using this formulism it is shown that placing four wall corrugations on each side of the Alcator C lower-hybrid-waveguide array increases its utility for current drive by better defining its low-n/sub z/ power spectrum. A method of calculating the effect of bellows on the reflection of lower-hybrid waves is also presented. This technique is applied to Alcator C to show that lower-hybrid waves having k/sub ko/ $< 4\ \omega/c$ can have a significant fraction of their RF power shifted to k/sub zo/ $+- 2\pi/d$ upon reflection, where d is the bellows spatial period. Furthermore, the shape of the incident RF power spectrum for k/sub zo/ $< 2\ \omega/c$ is distorted upon reflection. This effect can fundamentally modify wave trajectories that involve wall reflection.

30895 **(DOE/IG—0193) Mirror Fusion Test Facility Project, Lawrence Livermore National Laboratory, Livermore, California.** (USDOE Office of Inspector General, Washington, DC). 22 Apr 1983. 43p. USDOE-TIC, PO Bx 62, Oak Ridge, TN 37830.

Report to The Secretary.

Four areas of concern are addressed. The first concern involves the estimates for completing the project within projected costs and schedule. Although this project has been regularly reviewed by project personnel and others, an independent cost estimate of the project with emphasis on the contingency factor would be desirable to provide assurance of the soundness of the cost and schedule estimates. The second area of concern involves the design criteria being used to protect the main building of the project against earthquakes. Where protection for the project building is less than that afforded nuclear facilities at Livermore and may be inadequate to protect against earthquakes likely to occur in the area. The third area concerns the amount of contingency included in the estimated cost which has risen about 22% of the original estimated project costs. Again, an independent cost estimate could provide assurance on the reasonableness of the contingency factor. Finally, controls over at least $2 million of Government property purchased with project funds were not fully effective. This condition existed because the project followed a Livermore-wide policy of accounting for property that was inconsistent with Department instructions for budgeting, accounting for, and controlling such property. Recommendations to improve each of the matters are discussed. Comments and proposed actions by the Director of Office of Energy Research are appended. (PSB)

30896 **(EUR-CEA-FC—1140) MVA amplifier used for plasma position control in the WEGA tokamak.** Schenk, G. (Association Euratom-CEA, Centre d'Etudes Nucleaires de Grenoble, 38 (France). Dept. de Recherches sur la Fusion Controlee). Feb 1982. 24p. NTIS (US Sales Only), PC A02/MF A01. Order Number DE83700214.

A new amplifier has been developed for the control of the plasma positron in the WEGA III tokomak acting on the vertical magnetic field. In the high power domain thyristor choppers are usually applied. Unfortunately their response time is quite long and does not yet correspond to the WEGA demand. Therefore transistors have been used to build a fast switching amplifier of the H-bridge type, delivering a power of 1 MVA, by switching 2500 A at 400 V. Because of the duty cycle of the plasma (0,12 s every 240 s) the necessary average power to the amplifier supply is only 500 VA. An intermediate energy storage in an electrolytic capacitor bank is therefore used. As the switching transistors must operate under extreme conditions of voltage and current, precautions must be taken to limit the overvoltage and the overcurrent, to prevent oscillations and to assure power and control equilibrium among the transistors.

30897 **(EUR-CEA-FC—1143) TORE SUPRA: programme of development, qualifying tests. Summary and results.** Aymar, R.; Bareyt, B.; Bon Mardion, G. (Association Euratom-CEA, Centre d'Etudes Nucleaires de Fontenay-aux-Roses, 92 (France). Dept. de Recherches sur la Fusion Controlee). Feb 1982. 84p. NTIS (US Sales Only), PC A05/MF A01. Order Number DE83700215.

TORE SUPRA is a Tokamak under construction in France. It is designed as a useful complement to JET. In this paper, we review the development work and test programme, and summarize its main objectives and conclusions. This concerns first the more conventional parts of the Tokamak (vacuum vessel technology and high power circuit breaker for the poloidal field system) followed by a large amount of work about the superconducting coils.

30898 **(EUR-CEA-FC—1145) Gas recycling studies on the TFR Tokamak.** (Association Euratom-CEA, Centre d'Etudes Nucleaires de Fontenay-aux-Roses, 92 (France). Dept. de Recherches sur la Fusion Controlee). Mar 1982. 19p. (CONF-820545—21). NTIS (US Sales Only), PC A02/MF A01. Order Number DE83700216.

From 5. international conference on plasma surface; Gatlinburg, TN, USA (3 May 1982).

Gas recycling has been studied in a large number of tokamaks for several years. On TFR, a previous experiment with an inconel limiter had shown that, after many discharges in hydrogen, when we change the working gas to deuterium the wall adsorbed isotope accounts for less than 5% after a few shots. In order to have a better knowledge of the gas recycling we have done similar experiments with two different limiters -an inconel limiter and a graphite limiter- at room temperature and with hot walls ($250°C<T<300°$). With the graphite limiter, when the filling gas is changed from 100% H_2 to 100% D_2, the isotopic ratio H/H+D is between 25 and 30% after five shots and reaches the limit for approximately 12% after ten shots. This ratio decreases more rapidly with hot walls but the lower limit is higher: 10 and 20% with inconel and graphite limiters respectively, instead of 5% and 12% at room temperature. The recycling coefficient is a always higher with hot walls; this consequently should reduce the plasma edge temperature. The sputtering and the thermal load on the wall and the limiters might then also decrease.

30899 (GA-A—16979) 60 GHZ transmission system for the Doublet III electron cyclotron heating experiment. Moeller, C.P.; Prater, R.; Lin, S.H. (GA Technologies, Inc., San Diego, CA (USA)). Mar 1983. Contract AT03-76ET51011. 7p. (CONF-830210—9). NTIS, PC A02/MF A01. Order Number DE83010005.

From 5. topical conference on radio frequency plasma heating; Madison, WI, USA (21 Feb 1983).

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The transmission and launching scheme being used for the ECH experiments at 60 GHz on Doublet III and its operation at high power is described. The system uses the TE_{01} to TE_{11} mode converter at the antenna. The system provides an acceptable load to the gyrotron, rarely arcs, and maintains good mode purity.

30900 (GA-A—17011) Design of a high-power ICRF experiment for DIII. Rawls, J.M.; Blau, F.; Chiu, S.C.; Freeman, R.L.; Remsen, D. (GA Technologies, Inc., San Diego, CA (USA)). Feb 1983. Contract AT03-76ET51011. 7p. (CONF-830210—11). NTIS, PC A02/MF A01. Order Number DE83009987.

From 5. topical conference on radio frequency plasma heating; Madison, WI, USA (21 Feb 1983).

A synopsis is presented of a proposal to install a 20 MW, 10 second, 55 MHz system on DIII as reconfigured with a large dee-shaped vacuum vessel. The experimental emphasis will be on the achievement of high β, high n tau T conditions via second harmonic heating. The hardware configuration has been chosen with the intent of qualifying ICRF for use in reactor applications.

30901 (GA-A—17026) Preliminary electron-cyclotron-heating results on Doublet III using an outside launch. Prater, R.; Moeller, C.P.; Lin, S.H. (GA Technologies, Inc., San Diego, CA (USA)). Mar 1983. Contract AT03-76ET51011. 6p. (CONF-830210—12). NTIS, PC A02/MF A01. Order Number DE83010196.

From 5. topical conference on radio frequency plasma heating; Madison, WI, USA (21 Feb 1983).

Electron-cyclotron-heating experiments have been carried out on the Doublet III tokamak. Two 60-GHz gyrotrons were used to generate about 255 kW of power delivered to the plasma in the ordinary-mode polarization. The antenna launches a 16° FWHM beam from the large major radius side (outside) of the plasma at a beam center angle of 12° from a major radius. Pulses up to 85 msec long were applied, with the fundamental resonance (21.4 kG) near the plasma center. Plasma current was 300 to 350 kA, and the configuration was mostly expanded boundary with an elongation of 1.4 to 1.6 and density of 2 to 3 x 10^{13} cm^{-3}. Electron-temperature increases up to 1 keV at the plasma center due to ECH are found by Thomson scattering and electron-cyclotron radiation at the second harmonic. Soft x-ray analysis also shows central electron heating and profile broadening when the resonance is moved outside of the plasma center.

30902 (IAE—3413/7) Tokamak-7 device structure. Ivanov, D.P.; Kovalenko, V.D.; Efimov-Ilovajskij, A.V. (Gosudarstvennyj Komitet po Ispol'zovaniyu Atomnoj Ehnergii SSSR, Moscow. Inst. Atomnoj Ehnergii). 1981. 31p. (In Russian). NTIS (US Sales Only), PC A03/MF A01. Order Number DE83700217.

The Tokamak-7 device represents the first tokamak with a superconducting winding of a toroidal magnetic field. The main purpose of the device construction is to gain experience in tokamak design with superconducting windings. Magnetic field on the axis of the system is 3 Tl, maximum field on the winding surface - 5 Tl, maximum plasma current - 400 kA, plasma current field - 0.2 Tl. The device represents a multilayer toroidal construction comprising an internal discharge chamber, internal nitrogen shield, superconducting toroidal field magnetic system, external nitrogen shield and cryostat case. The vortex field and controlling fields windings are located outside the cryostat. The T-7 device by their geometric parameters only slightly differs from the T-10. It is used for fast information buildup in average fields and gives the possibility to discharge T-10 from work under these regimes.

30903 (IAE—3431/7) Dependence of the tokamak chamber sputtering intensity on its cleaning technique. Vertiporokh, A.N.; Gegechkori, N.M.; Esipchuk, Yu.V.; Kovrov, P.E.; Maksimov, Yu.S.; Notkin, G.E.; Pimenov, A.B.; Razumova, K.A.; Rantsev-Kartinov, V.A.; Chicherov, V.M. (Gosudarstvennyj Komitet po Ispol'zovaniyu Atomnoj Ehnergii SSSR, Moscow. Inst. Atomnoj Ehnergii). 1981. 12p. (In Russian). NTIS (US Sales Only), PC A02/MF A01. Order Number DE83700218.

Investigations of effective charge and impurity composition of plasma under various methods of T-10 tokamak walls cleaning and discharge formation conditions are carried out. The concentration of metallic impurities has been measured on absolute intensity of K-lines of proper elements while the concentration of light impurities-on intensity exceeding of the measured x radiation continuum in the 2.5-5 keV energy range above the one expected in hydrogen plasma. The following conclusions are drawn: To obtain a reliably reproducible regime with low values of stability margin the heavy impurity concentration must not exceed one hundredth percent. The limited inlet of light impurities gives the possibility to form profiles of current density distribution on the plasma filament periphery which correspond to the low level of MHD activity. Sputtering intensity depends on state of the wall- it is lower in the case when the wall is covered with oxides, on the width of a behind diaphragm region a sharp decrease of metal concentration at the diaphragm "shadow" increase above the threshold, on plasma parameters in the near wall region which can be affected by blowing down neutral gas in the discharge process. A great energy strength on graphite diaphragm leads to its strong sputtering.

30904 (IAE—3433/6) Compression of the thermonuclear fuel targets by charged particle beams. Part 2. Gurevich, A.I. (Gosudarstvennyj Komitet po Ispol'zovaniyu Atomnoj Ehnergii SSSR, Moscow. Inst. Atomnoj Ehnergii). 1981. 32p. (In Russian). NTIS (US Sales Only), PC A03/MF A01. Order Number DE83700219.

The process of irradiation of targets consisting of DT-mixture covered with a gold shell, by electron and ion beams is analytically investigated. The DT-mixture is compressed for account of thermal shell expansion, warms up and the DT-reaction occurs in it with energy release. Main attention in the study is given to qualitative and semiquantitative consideration of these phenomena: Plane (unit square layer limited on the DT-mixture side by an impenentrable wall), cylindrical (unit height cylinder) and spherically-symmetric targets. Analytical formulas of calculation of energy DT-reaction yield depending on irradiation conditions are derived. The comparison of results of calculations by formulas with the computer numerical solution of hydrodynamics equations has shown that formulas satisfactorily described the processes under consideration. The reason of better efficiency of target irradiation by protons and generally by ions than electrons is discussed. The conclusion is drawn that at target irradiation by ions a considerably greater part of kinetic energy of internal layers of the shell transfers into the DT-mixture internal energy and DT-mixture compression is closer to the adiabatic one, than at electron irradiation.

30905 (JAERI-M—9599) Countermeasure for unneutralized ion beam in JT-60 NBI against the leakage magnetic field from JT-60. Matsuoka, M.; Itoh, T.; Horiike, H.; Matsuda, S.; Tanaka, S. (Japan Atomic Energy Research Inst., Tokyo). Aug 1981. 26p. (In Japanese). NTIS (US Sales Only), PC A03/MF A01. Order Number DE83701516.

Unneutralized ion beam in JT-60 neutral beam injector will be magnetically bent by the reflecting magnet and will impinge on the surface of the water jacket protecting the magnet and on the surface of the beam dump. When the JT-60 Tokamak operates, leakage magnetic field generated by the poloidal currents will be superposed on the above magnetic field. As a result, the trajectory of the ion beam will be displaced and the heat loading of the water jacket and the beam dump will exceed a permissible level unless careful attention is paid to the magnetic field design. As one of the countermeasures against the leakage field, we first considered the magnetic shielding. After the numerical and experimental study, however, it was found difficult to obtain the satisfactory shielding factor due to lack of space. As another countermeasure, the cancel-

lation of magnetic field by a set of additional coils (Cancellation Coils) was proposed and studied. the result showed that the cancellation was effective to reduce the leakage field to a sufficiently low value. Therefore we decided to adopt it in the JT-60 NBI design.

30906 **(KMSF-U—1263) Laser fusion. Quarterly progress report, Aporil-June 1982.** (KMS Fusion, Inc., Ann Arbor, MI (USA)). 1982. Contract AC08-82DP40152. 37p. NTIS, PC A03/MF A01. Order Number DE83010807.

We continued to make progress toward understanding the solidification of cryogenic fuel layers in glass Microshell targets. The cryogenic target series, intended to produce high density implosions, continued this quarter with the use of 0.53 μm laser light. The thermal transport experimental campaign was successfully concluded using 1.05 μm laser irradiation. Results were obtained over a decade of absorbed laser intensities. This extended the range of previously reported data taken at lower intensities. K/sub alpha/ x-ray signals from Titanium and Vanadium inner layers were used to measure suprathermal electron transport. Good signals were obtained only at the highest laser intensities and for the thinnest layers of absorbing material.

30907 **(LA-UR—83-586) Convective transport in laser target plasmas.** Brackbill, J.U.; Colombant, D.; Grandjouan, N. (Los Alamos National Lab., NM (USA); Naval Research Lab., Washington, DC (USA); Ecole Polytechnique, 91 - Palaiseau (France)). 1982. Contract W-7405-ENG-36. 17p. (CONF-8209113—3). NTIS, PC A02/MF A01. Order Number DE83009939.

From CECAM workshop; Paris, France (13 Sep 1982).

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The role of guiding-center corrections in convective transport of electron energy is examined with a simple numerical model. At 10^{16}W cm^{-3} with a 60-μm spot and a 10.6-μm wavelength laser, the Righi-Leduc term is observed to have little effect on transport in a calculation with the thermal flux limited to the free-streaming value.

30908 **(LA-UR—83-691) Tritium monitoring within the reactor hall of a DT fusion reactor.** Jalbert, R.A. (Los Alamos National Lab., NM (USA)). 1983. Contract W-7405-ENG-36. 5p. (CONF-830406—14). NTIS, PC A02/MF A01. Order Number DE83009978.

From 5. topical meeting on technology of fusion energy; Knoxville, TN, USA (26 Apr 1983).

Monitoring the reactor hall atmosphere of DT-fueled fusion reactors will probably be performed with conventional ion chamber and proportional counter instruments modified as necessry to deal with the background radiation. Background includes external neutron and gamma radiation and internal beta-gamma radiation from the activated atmosphere. Although locating instruments in remote areas of the reactor hall and adding local shielding and electronic compensation may be feasible, placing the instruments in accessible low-background areas outside of the reactor hall and doing remote sampling is preferable and solves most of the radiation problems. The remaining problem of the activated atmosphere may be solved by recently developed instruments in conjunction with the use of semi-permeable membranes currently under development and evaluation.

30909 **(LA-UR—83-716) Assembly and installation of the 2 MeV FMIT accelerator.** Liska, D.; Michelotti, R. (Los Alamos National Lab., NM (USA)). 1983. Contract W-7405-ENG-36. 4p. (CONF-830311—80). NTIS, PC A02/MF A01. Order Number DE83009959.

From Particle accelerator conference; Santa Fe, NM, USA (21 Mar 1983).

The front end of the 35-MeV Fusion Materials Irradiation Test (FMIT) Facility accelerator is being assembled and installed at Los Alamos. The machine ultimately will produce a 500-kW continuous-duty beam at 5 MeV, although only the first 2 MeV will be installed this year. The 2-MeV system will include the most-powerful radio-frequency quadrupole (RFQ) in existence. The assembly and installation of the hardware are described, along with the unique problems arising from the large size and high power of the components involved.

30910 **(LA-UR—83-817) Structural-design considerations for the FED 50-kA equilibrium field coils.** Buchanan, G.; Bennett, J.G. (Los Alamos National Lab., NM (USA)). 1983. Contract W-7405-ENG-36. 6p. (CONF-830406—20). NTIS, PC A02/MF A01. Order Number DE83009998.

From 5. topical meeting on technology of fusion energy; Knoxville, TN, USA (26 Apr 1983).

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The structural support system for two equilibrium field coil conductor concepts is considered for the fusion energy design (FED) 8/10T baseline magnetic-fusion system. Both conductor concepts are discussed. Results indicate that regardless of the conductor concept employed, an external support beam/frame structural system is required to equilibrate the accumulative loadings.

30911 **(LA-UR—83-930) Compact fusion reactors.** Krakowski, R.A.; Hagenson, R.L. (Los Alamos National Lab., NM (USA); Technology International, Inc., Ames, IA (USA)). 1983. Contract W-7405-ENG-36. 12p. (CONF-830406—13). NTIS, PC A02/MF A01. Order Number DE83009898.

From 5. topical meeting on technology of fusion energy; Knoxville, TN, USA (26 Apr 1983).

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Compact, high-power-density approaches to fusion power are proposed to improve economic viability through the use of less-advanced technology in systems of considerably reduced scale. The rationale for and the means by which these systems can be achieved are discussed, as are unique technological problems.

30912 **(LA-UR—83-931) Modular stellarator reactor conceptual design study.** Miller, R.L.; Krakowski, R.A.; Bathke, C.G. (Los Alamos National Lab., NM (USA); Westinghouse Electric Corp., Madison, PA (USA); Stone and Webster Engineering Corp., Boston, MA (USA)). 1983. Contract W-7405-ENG-36. 7p. (CONF-830406—11). NTIS, PC A02/MF A01. Order Number DE83009899.

From 5. topical meeting on technology of fusion energy; Knoxville, TN, USA (26 Apr 1983).

A conceptual design study of the Modular Stellarator Reactor is summarized. The physics basis of the approach is elucidated with emphasis on magnetics performance optimization. Key engineering features of the fusion power core are described. Comparisons with an analogous continuous-helical-coil (torsatron) system are made as the basis of a technical and economic assessment.

30913 **(LA-UR—83-952) ANTHEM: a two-dimensional multicomponent self-consistent hydro-electron transport code for laser-matter interaction studies.** Mason, R.J. (Los Alamos National Lab., NM (USA)). 1982. Contract W-7405-ENG-36. 16p. (CONF-8210137—1). NTIS, PC A02/MF A01. Order Number DE83009904.

From CECAM workshop on the flux-limiter and heat flow instabilities; Orsay, France (1 Oct 1982).

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The ANTHEM code for the study of CO_2-laser-generated transport is outlined. ANTHEM treats the background plasma as coupled Eulerian thermal and ion fluids, and the suprathermal electrons as either a third fluid or a body of evolving collisional PIC particles. The electrons scatter off the ions; the suprathermals drag against the thermal background. Self-consistent E- and B-fields are computed by the Implicit Moment Method. The current status of the code is described. Typical output from ANTHEM is discussed with special application to Augmented-Return-Current CO_2-laser-driven targets.

30914 **(LA-UR—83-968) Development of the two-dimensional cross-section sensitivity and uncertainty analysis code SENSIT-2D with applications to the FED.** Embrechts, M.J.; Dudziak, D.J.; Urban, W.T. (Los Alamos National Lab., NM (USA)). 1983. Contract W-7405-ENG-36. 9p. (CONF-830406—18). NTIS, PC A02/MF A01. Order Number DE83009910.

From 5. topical meeting on technology of fusion energy; Knoxville, TN, USA (26 Apr 1983).

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Sensitivity and uncertainty analyses implement the information obtained from a transport code by providing a reasonable estimate for the uncertainty of a particular design parameter and a better understanding of the nucleonics involved. The toroidal geometry of many fusion devices motivates a two-dimensional calculation capability. A two-dimensional cross-section and secondary energy distribution (SED) sensitivity and uncertainty analysis code, SENSIT-2D, has been developed that allows modeling of a toroidal geometry. Two-dimensional and one-dimensional sensitivity analyses for the heating and the copper d.p.a. of the TF coil for a conceptual FED blanket/shield design were performed. The uncertainties from the two-dimensional analysis are of the same order of magnitude as those obtained from the one-dimensional study. The largest uncertainties were caused by the cross-section covariances for chromium.

30915 **(LA-UR—83973) Status of tritium technology development for magnetic-fusion energy.** Anderson, J.L. (Los Alamos National Lab., NM (USA)). 1983. Contract W-7405-ENG-36. 9p. (CONF-830406—19). NTIS, PC A02/MF A01. Order Number DE83009911.

From 5. topical meeting on technology of fusion energy; Knoxville, TN, USA (26 Apr 1983).

The development of tritium technology for the magnetic fusion energy program has progressed at a rapid rate over the past two years. The focal points for this development in the United States have been the Tritium Systems Test Assembly at Los Alamos and the FED/INTOR studies supported by the Fusion Engineering Design Center at Oak Ridge. In Canada the Canadian Fusion Fuel Technology Project has been initiated and promises to make significant contributions to the tritium technology program in the next few years. The Japanese government has now approved funding for the Tritium Processing Laboratory at the Japan Atomic Energy Research Institute's Tokai Research Establishment. Construction on this new facility is scheduled to begin in April 1983. This facility will be the center for fusion tritium technology development in Japan. The European Community is currently working on the design of the tritium facility for the Joint European Torus. There is considerable interaction between all of these programs, thus accelerating the overall development of this crucial technology.

30916 **(MPQ—64) ICF-target studies for heavy ion fusion.** Meyer-ter-Vehn, J. (Max-Planck-Institut fuer Quantenoptik, Garching (Germany, F.R.)). Jul 1982. 31p. Available from Max-Planck-Institut fuer Quantenoptik, Garching (Germany, F.R.).

From Symposium on accelerator aspects of heavy ion fusion; Darmstadt (Germany, F.R.) (29 Mar - 2 Apr 1982).

In this talk, work on ICF targets for Heavy Ion Fusion (HIF) performed at the Max-Planck-Institut for Quantum Optics (MPQ) at Garching in the period 1979-1982 is presented. It is part of the German feasibility study of inertial confinement fusion (ICF) by means of heavy ions beams. Within this project target aspects are also studied at the Kernforschungszentrum Karlsruhe with emphasis on thermonuclear burn and transport in a reactor cavity and at the universities in Frankfurt and Darmstadt with focus on symmetry aspects and more-dimensional simulation.

30917 **(NIIEFA-P-B—0510) To the calculation of the mutual inductance coefficient in a toroidal-sector magnet system.** Mingalev, B.S. (Nauchno-Issledovatel'skij Inst. Ehlektrofizicheskoj Apparatury, Leningrad (USSR)). 1981. 35p. (In Russian). NTIS (US Sales Only), PC A03/MF A01. Order Number DE83700222.

The analytical method of calculation characteristics of the magnet system consisting of several toroidal-sector coils and ferromagnetic body limited by cylindrical surfaces is proposed. The particular case of such system is realized as a component of a toroidal magnet system of the tokamak type device. As examples analytical formulas for calculation of the following values: a force effecting on the magnet coil, coefficient of self induction and mutual induction of magnet coils, are presented. Specific numerical calculations of the above values are presented too.

30918 **(ORNL/CSD/TM—199) User's guide to FFE: a fast front end data acquisition program.** Million, D.L. (Oak Ridge National Lab., TN (USA)). Mar 1983. Contract W-7405-ENG-26. 22p. NTIS, PC A02/MF A01. Order Number DE83010405.

The Large Coil Test Facility project of Fusion Energy Division has a data acquisition system which includes a large host computer and several small, peripheral front-end computers. The front-end processors handle details of data acquisition under the control of the host and pass data back to the host for storage. Some of the front ends are known as fast front ends and are required to collect a maximum of 64,000 samples each second. This speed and other hardware constraints resulted in a need for a stand-alone, assembly language task which could be downline loaded from the host system into the fast front ends. FFE (Fast Front End) was written to satisfy this need. it was written in the PDP11 MACRO-11 assembly language for an LSI-11/23 processor. After the host loads the task into the front end, it controls the data acquisition process with a series of commands and parameters. This User's Guide describes FFE and how to use it from the host system. A companion Programmer's Guide provides more detailed information on the structure of the program.

30919 **(ORNL/FEDC—82/2) FED baseline engineering studies report.** Sager, P.H. (Oak Ridge National Lab., TN (USA)). Apr 1983. Contract W-7405-ENG-26. 472p. NTIS, PC A20/MF A01. Order Number DE83010328.

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Studies were carried out on the FED Baseline to improve design definition, establish feasibility, and reduce cost. Emphasis was placed on cost reduction, but significant feasibility concerns existed in several areas, and better design definition was required to establish feasibility and provide a better basis for cost estimates. Design definition and feasibility studies included the development of a labyrinth shield ring concept to prevent radiation streaming between the torus spool and the TF coil cryostat. The labyrinth shield concept which was developed reduced radiation streaming sufficiently to permit contact maintenance of the inboard EF coils. Various concepts of preventing arcing between adjacent shield sectors were also explored. It was concluded that installation of copper straps with molybdenum thermal radiation shields would provide the most reliable means of preventing arcing. Other design studies included torus spool electrical/structural concepts, test module shielding, torus seismic response, poloidal conditions in the magnets, disruption characteristics, and eddy current effects. These additional studies had no significant impact on cost but did confirm the feasibility of the basic FED Baseline concept.

30920 **(ORNL/SUB—79-33200/12) Development program for a 200-kW, c-w gyrotron. Quarterly report No. 12, April-June 1982.** DeHope, W.J.; Caplan, M.; Ferguson, P.E.; Matranga, V.A.; Sandoval, J.J.; Tancredi, J.J. (Hughes Aircraft Co., Torrance, CA (USA). Electron Dynamics Div.). 1982. Contract W-7405-ENG-26. 34p. NTIS, PC A03/MF A01. Order Number DE83010911.

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The objective of this program is the design and development of a millimeter-wave device to produce 200 kW of continuous-wave power at 60 GHz. The device, a gyrotron oscillator, will be compatible with power delivery to an electron-cyclotron-heated plasma. During this report period, extensive low-duty testing on the 20-μs modulator was performed, achieving 285 kW at 44% beam efficiency. The beam instability that plagued S/N 1 and resulted in excessive mod-anode interception current was circumvented with a smaller beam hole in the end of the lossy drift tube between cathode and cavity, and by operating the tube with a positively tapered magnetic field over the cathode. A new design optimization of the magnetron-injection gun was completed for use in the tapered magnetic field. Work on the collector was also accomplished including a study of the beam distribution using several defferent diagnostic techniques, a redesign of the ceramic insulating seals, and a full-scale mock-up of the c-w collector for mechanical integrity under high flow rates. Preliminary testing of S/N 2 was begun. Progress on the c-w facility continued.

30921 (ORNL/SUB—79-33200/13) Development program for a 200-kW, c-w gyrotron. Quarterly report No. 13, July-September 1982. Ferguson, P.E.; DeHope, W.J.; Matranga, V.A.; Sandoval, J.J.; Schmitt, M.J.; Tancredi, J.J. (Hughes Aircraft Co., Torrance, CA (USA). Electron Dynamics Div.). 1982. Contract W-7405-ENG-26. 28p. NTIS, PC A03/MF A01. Order Number DE83010912.

The objective of this program is the design and development of a millimeter-wave device to produce 200 kW of continuous wave power at 60 GHz. Testing continued on gyrotron S/N 1A and S/N 2 during this report period. S/N 1A attained a peak power level of 285 kW under short pulse conditions. Long pulse measurements up to 100 ms were attempted with the tube detuned for minimum output power. A problem with the RF water load limits the maximum power level at which the tube will operate. S/N 2 was tested with pulse widths up to 15 μs. This tube appears to have a limited operating region, and the cause of this limitation is being investigated. A mock-up of the collector cooling scheme for the CW gyrotron was constructed in order to determine the integrity of the thin fins. A flow of 345 gpm (limited by the source) was obtained with a reasonable pressure drop of 60 psi. This assembly operated for one hour with no apparent damage. A new, broader band window for use on CW gyrotrons has been designed and fabrication has started. Progress was made on the Gyrotron CW test facility.

30922 (ORNL/TM—8616) New algorithm for computing the ablation of hydrogenic pellets in hot plasmas. Milora, S.L. (Oak Ridge National Lab., TN (USA)). Apr 1983. Contract W-7405-ENG-26. 28p. NTIS, PC A03/MF A01. Order Number DE83010447.

A method is presented for calculating the evaporation rate of hydrogenic pellets immersed in an unmagnetized plasma with a suprathermal particle component of arbitrary distribution function. The computational procedure is based on hydrodynamic solutions for the expansion of the gaseous cloud, obtained in a previous treatment that considered the effects of thermal particles only. The appropriate heat source terms, derived from the stopping power of the gaseous shield, are worked out for energetic ions produced by neutral beam injection heating. The model predicts 27-cm penetration in a Poloidal Divertor Experiment (PDX) plasma, compared with experimentally measured values in the range of 29 to 32 cm. An application to the Tokamak Fusion Test Reactor (TFTR) gives an estimated 21-cm penetration for a 2.5-mm-diam tritium pellet injection at 2000 m/s into a 55-cm-bore plasma heated to a central electron temperature of 4 keV by 34 MW of neutral injection.

30923 (PPPL—1987) Particle and energy transport in the plasma scrape-off zone and its impact on limiter design. Ulrickson, M.; Post, D.E. (Princeton Univ., NJ (USA). Plasma Physics Lab.). Mar 1983. Contract AC02-76CH03073. 16p. NTIS, PC A02/MF A01. Order Number DE83010845.

The design of limiters for fusion devices depends critically on the transport properties of the plasma edge. Recent data from Langmuir Probe experiments and calorimeter probe experiments on the Poloidal Divertor Experiment (PDX) have provided information about the transport of particles and energy in the edge region of a plasma. These data have been used as input to a simple one-dimensional model in which the particle and thermal diffusion coefficients are permitted to be functions of the density and temperature. The transport coefficients deduced from the data are then applied to the cases of the TFTR device and a device like FED/INTOR to predict the optimum design for limiters or pump limiters. The results indicate the optimum limiter should have a concave shape when viewed from the plasma. The effect of the uncertainties in the deduced coefficients on the optimum design performance are also discussed.

30924 (PPPL—1998) Closed expressions for the magnetic field of toroidal multipole configurations. Sheffield, G.V. (Princeton Univ., NJ (USA). Plasma Physics Lab.). Apr 1983. Contract AC02-76CH03073. 16p. NTIS, PC A02/MF A01. Order Number DE83010839.

Closed analytic expressions for the vector potential and the magnetic field for the lower order toroidal multipoles are presented. These expressions can be applied in the study of tokamak plasma cross section shaping. An example of such an application is included. These expressions also allow the vacuum fields required for plasma equilibrium to be specified in a general form independent of a particular coil configuration.

30925 (SAND—83-0168) Analytic scaling laws related to beam and return-current stability in particle-beam-driven ICF target regions. Swegle, J.A. (Sandia National Labs., Albuquerque, NM (USA)). Mar 1983. Contract AC04-76DP00789. 65p. NTIS, PC A04/MF A01. Order Number DE83010181.

Using a simplified model of a homogeneous, unbounded, time-independent background plasma and an unbounded, charge- and current-neutralized ion beam, the linear stability of beam- and return-current-driven modes has been analyzed in parameter regimes appropriate to both light- and heavy-ion-driven inertial-confinement-fusion target regions. The purpose of this report is to derive analytic scaling laws which reveal those regions in parameter space and those modes of interaction, both electrostatic and electromagnetic, which could present problems. It is found that instabilities are typically not a concern until the density of background ions drops below about 0.01% of solid density. Growth rates are presented, and the stabilizing influences of beam overlap and plasma-density gradients are discussed quantitatively and qualitatively.

30926 (UCID—19739) Electrical energy and cost for the Mirror Fusion Test Facility. Pence, G.A. (Lawrence Livermore National Lab., CA (USA)). Feb 1983. Contract W-7405-ENG-48. 57p. NTIS, PC A04/MF A01. Order Number DE83010982.

An operational scenario for the Mirror Fusion Test Facility has been developed based on System Requirements, experience with existing systems, and discussions with project engineers and designers who are responsible for the systems. This scenario was used to project the electrical energy required for the facility. Each system is listed showing the equipment that has been considered, the amount of power requested, and in most cases, the power that it is now connected.

30927 (UCID—19743) Options to upgrade the Mirror Fusion Test Facility. Thomassen, K.I.; Doggett, J.N. (eds.). (Lawrence Livermore National Lab., CA (USA)). Apr 1983. Contract W-7405-ENG-48. 182p. NTIS, PC A09/MF A01. Order Number DE83009696.

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In this document we describe three options for upgrading MFTF-B, and the nomenclature used for these options is shown on the chart, MFTF-B Upgrade Options. We propose to add a 4-m-long reactor-like insert to the central cell, or to change the end plugs to the new MARS-type configuration, or both. LLNL prefers the third option, labeled MFTF-α^+T in the chart, in which both the central cell insert is added and the end plugs are modified. All options are long-pulse or steady-state DT burning experiments. Those upgrades with the insert would be constructed beginning in FY 86, with operation beginning in mid-FY 92. Confirmation of our intent to modify the end plugs would be sought in FY 88 based on positive results from MFTF-B experiments. The upgrade with only the end plug modification would not start until MFTF-B data are available. The timeline for constructing and operating the MFTF-B Upgrade included at the end of this preface is for reference while reading the text. The various modes of operation shown on the chart are described later.

30928 (UCRL—53356) Electromagnetic pumping of liquid lithium in inertial confinement fusion reactors. Baker, R.S.; Blink, J.A.; Tessier, M.J. (Lawrence Livermore National Lab., CA (USA)). 1 Mar 1983. 39p. NTIS, PC A03/MF A01. Order Number DE83010359.

The basic operating principles and geometries of ten electromagnetic pumps are described. Two candidate pumps, the annular-linear-induction pump and the helical-rotor electromagnetic pump, are compared for possible use in a full-scale liquid-lithium inertial confinement fusion reactor. A parametric design study completed for the helical-rotor pump is shown to be valid when applied to an

experimental sodium pump. Based upon the preliminary HYLIFE requirements for a lithium flow rate per pump of 8.08 m^3/s at a head of 82.5 kPa, a complete set of 70 variables are specified for a helical-rotor pump with either a normally conducting or a superconducting winding. The two alternative designs are expected to perform with efficiencies of 50 and 60%, respectively.

30929 **(UCRL—88056) Scaling of laser-plasma interactions with laser wavelength and plasma size.** Max, C.E.; Campbell, E.M.; Mead, W.C.; Kruer, W.L.; Phillion, D.W.; Turner, R.E.; Lasinski, B.F.; Estabrook, K.G. (Lawrence Livermore National Lab., CA (USA)). 25 Jan 1983. Contract W-7405-ENG-48. 21p. (CONF-821089—9). NTIS, PC A02/MF A01. Order Number DE83010103.

From 6. international workshop on laser interaction and related plasma phenomena; Monterey, CA, USA (25 Oct 1982).

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Plasma size is an important parameter in wavelength-scaling experiments because it determines both the threshold and potential gain for a variety of laser-plasma instabilities. Most experiments to date have of necessity produced relatively small plasmas, due to laser energy and pulse-length limitations. We have discussed in detail three recent Livermore experiments which had large enough plasmas that some instability thresholds were exceeded or approached. Our evidence for Raman scatter, filamentation, and the two-plasmon decay instability needs to be confirmed in experiments which measure several instability signatures simultaneously, and which produce more quantitative information about the local density and temperature profiles than we have today.

30930 **(UCRL—88208) CASCADE: a centrifugal-action solid-breeder reaction chamber.** Pitts, J.H. (Lawrence Livermore National Lab., CA (USA)). 1983. Contract W-7405-ENG-48. 16p. (CONF-830406—21). NTIS, PC A02/MF A01. Order Number DE83010612.

From 5. topical meeting on technology of fusion energy; Knoxville, TN, USA (26 Apr 1983).

The Cascade concept uses the high-temperature (1200 K) potential of a solid Li_2O pebble blanket in conjunction with centrifugal action to produce a safe and highly efficient (up to 55%) reaction chamber for commercial power production. One option using a 25-mm-thick steel wall is shown to have low primary stresses of 22 MPa, which when coupled with a secondary thermal stress of 132 MPa, satisfies the intent and methodology for an ASME-designed vessel. A high tritium breeding ratio of 1.35 results from direct exposure of the Li_2O blanket to the fusion reactions. Vacuum pumping requirements of the chamber, using laser drivers at a pressure of 0.1 Torr, are a modest 4.7 m^3/s for D-T and 3.1 m^3/s for helium. Carbon-14 activation in the blanket is insignificant. We conclude that the Cascade concept offers an attractive option for a safe and efficient inertial fusion reaction chamber.

30931 **(UCRL—88527) Tandem mirrors for neutron production.** Doggett, J.N. (Lawrence Livermore National Lab., CA (USA)). 31 Mar 1983. Contract W-7405-ENG-48. 12p. (CONF-830406—16). NTIS, PC A02/MF A01. Order Number DE83009846.

From 5. topical meeting on technology of fusion energy; Knoxville, TN, USA (26 Apr 1983).

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Two mirror machine concepts are being studied as early-time, low-cost, neutron-producing devices for testing and demonstrating reactor-relevant fusion technology. The first of these concepts is for a new, small, driven, steady-state, D-T reactor, called the Technology Demonstration Facility (TDF). The second concept is for upgrades to the MFTF-B machine that burn tritium and run for pulse lengths of some hours. Both devices operate in the Kelley mode in order to provide high-wall loadings of 14-MeV neutrons, thereby providing a valuable test bed for reactor-relevant hardware and subsystems. Either one of these devices could be running in the early 1990's with first wall fluxes between 1.4 and 2.0 $MW\ m^{-2}$.

30932 **(UCRL—88977) Overview and direction in the tandem mirror program.** Thomassen, K.I. (Lawrence Livermore National Lab., CA (USA)). Apr 1983. Contract W-7405-ENG-48. 13p. (CONF-830406—17). NTIS, PC A02/MF A01. Order Number DE83010257.

From 5. topical meeting on technology of fusion energy; Knoxville, TN, USA (26 Apr 1983).

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There are two main thrusts to the tandem mirror program at the present time. One is to gather the experimental data base to verify the axicell thermal-barrier concept and the other to improve the end plugs for tandems. With such improvements one might approach the ideal fusion reactor, a simple solenoid of modular elements whose ends are but a modest perturbation on the configuration from both a cost and technological viewpoint. Progress toward these two goals is discussed here, and the directions to be taken in the immediate future are described.

30933 **(UCRL-Trans—11827) Study and use of the ion beams formed in the Focus experiment.** Bernard, A.; Garconnet, J.P.; Jolas, A.; le Breton, J.P.; de Mascureau, J. (CEA Centre d'Etudes Nucleaires de Saclay, 91 - Gif-sur-Yvette (France)). Mar 1983. Contract W-7405-ENG-48. C; CEA-R-5171. 48p. NTIS, PC A03/MF A01. Order Number DE83008903.

Portions are illegible in microfiche products.

Studies were performed in the 200 kJ Actime installation using CD_2 or LiD targets and permitted one to determine the characteristics of the ion beam which bombards the target. The measurement of the temperature attained by metal targets bombarded by deuterons is discussed. The use of a digital program permits one to calculate the amount of energy deposited. Finally, the improvements being considered and the future prospects offered by this type of experiment are discussed.

30934 **Light-atom neutral beams for tandem mirror end plugs.** Post, D.E.; Grisham, L.R. (Princeton Univ., NJ (USA). Plasma Physics Lab.); Santarius, J.F.; Emmert, G.A. (Wisconsin Univ., Madison (USA)). *Nuclear Fusion;* **23**: No. 1, 3-13(Jan 1983).

Paper copy only, copy does not permit microfiche production6 refs.

The advantages and feasibility of neutral beams with $Z >= 3$ formed from negative ions, accelerated to 0.5-1.0 $MeV.amu^{-1}$, and neutralized, are investigated for use in tandem mirror reactor end plugs. A reactor plasma physics design incorporating these beams has been done with the result that such a reactor could produce Q's (ratio of fusion power to injected power) of 20-30. These beams thus might be a replacement for the currently proposed 200-500-keV neutral proton beams presently planned for tandem mirror reactors. Thus these $Z >= 3$ neutral beams could increase the potential attractiveness of tandem mirror reactors by offering a possible substitute for difficult high-energy neutral-hydrogen end plug beams.

30935 **Effects of neutral-beam co- and counter-injection on impurity radiation from ISX-B plasmas.** Bush, C.E.; Bates, S.C.; Dunlap, J.L.; Lazarus, E.A.; Murakami, M.; Pare, V.K.; Thomas, C.E.; Thomas, B. Jr.; Wieland, R.M. (Oak Ridge National Lab., TN (USA)). *Nuclear Fusion;* **23**: No. 1, 67-73(Jan 1983).

In addition to heating, neutral beam injection modifies the impurity transport in ISX-B plasmas. Radiometric data show the effects of co- and counter-injection on impurity radiation profiles to be significantly different. Data from an array of twelve collimated detectors and an uncollimated monitor (all pyroelectric) show the radial distribution of volume impurity emission to be peaked at the centre of the discharge with counter-injection and at the plasma edge with co-injection, especially for Psub(inj) > 1 MW. At high co-injection power, only 20% of the total input power is lost as impurity radiation. Also, co-injection-heated discharges reach an equilibrium shortly after beam turn-on, whereas counter-injection-heated discharges do not reach equilibrium and usually terminate disruptively. It is conjectured that the disruption is due to modification of the plasma current distribution resulting from the extreme cooling at the plasma core.

30936 **Plasma physics and controlled nuclear fusion research. Summaries of the ninth IAEA international conference held in Baltimore, USA, 1-8 September 1982.** Furth, H.P. (Princeton Univ., NJ (USA). Plasma Physics Lab.); Kadomtsev, B.B. (Gosudarstvennyj Komitet po Ispol'zovaniyu Atomnoj Ehnergii SSSR, Moscow. Inst. Atomnoj Ehnergii); Yamanaka, C. (Osaka Univ. (Japan)); Lomer, W.M. (UKAEA Culham Lab., Abingdon). *Nuclear Fusion;* **23**: No. 1, 97-120(Jan 1983).

Papers dealing with the following topics were presented: magnetic confinement experiments (tokamak devices, tandem mirror machines, stellarators, elmo bumpy tori, reverse-field pinches, and compact tori); magnetic confinement theory (plasma instabilities, plasma heating, and high-β systems); inertial confinement fusion (laser and particle-beam drivers, targets concepts, and implosion mechanisms); reactor systems (tokamak reactors and alternative systems).

30937 **Stabilization of axisymmetric mirror plasmas by energetic ion injection.** Hinton, F.L.; Rosenbluth, M.N. (Texas Univ., Austin (USA). Inst. for Fusion Studies). *Nuclear Fusion;* **22**: No. 12, 1547-1557(Dec 1982).

Plasmas in axisymmetric mirror devices can be made stable to MHD interchange modes by injecting energetic ions which contribute significantly to the pressure and spend a sufficiently large fraction of a bounce time in regions of favourable curvature. Pitch-angle scattering adversely affects the method by reducing this fraction. The ions must be sufficiently energetic that pitch-angle scattering is not detrimental for that part of a slowing-down time during which they contribute significantly to the pressure. The authors have solved the bounce-averaged Fokker-Planck equation, including drag and pitch-angle scattering, and calculated the energetic ion contribution to the stability integral. With specially tailored magnetic fields, the required injection energy and power drain are found to be reasonable.

30938 **Impurity injection experiments on the Alcator C tokamak.** Marmar, E.S.; Rice, J.E.; Terry, J.L. (Massachusetts Inst. of Tech., Cambridge (USA). Plasma Fusion Center); Seguin, F.H. (American Science and Engineering, Inc., Cambridge, MA). *Nuclear Fusion;* **22**: No. 12, 1567-1575(Dec 1982).

Transport of trace, non-recycling, injected impurities has been studied on the Alcator C tokamak. Changes of impurity confinement times with varying plasma density, current, toroidal field, majority ion species mass, impurity charge and mass, Zsub(eff), and major and minor radius have been delineated. An empirical scaling is developed from these results and compared with the results of similar transport studies undertaken on other tokamak devices. The agreement is reasonable. A computer model simulating the transport is utilized to compare several models with the empirical results. With the possible exception of low-density, high-Zsub(eff) discharges, the transport is not consistent with the predictions of neoclassical theory, but can be well described by simple spreading diffusion with a diffusion coefficient ranging from 1 to 5×10^3 $cm^2.s^{-1}$, depending on plasma parameters. This model yields good agreement both with the time histories of single-chord measurements of various ionization states, and with radial soft-X-ray emission profiles. Increased impurity transport with the onset of strong MHD oscillations has also been observed, with the effective diffusion coefficient scaling approximately as $(\Delta B)^4$.

30939 **Experimental determination of vertical instability strength in PDX tokamak.** Takahashi, H.; Bol, K.; Okabayashi, M.; Reusch, M. (Princeton Univ., NJ (USA). Plasma Physics Lab.); Maeda, H. (Japan Atomic Energy Research Inst., Tokai, Ibaraki. Tokai Research Establishment). *Nuclear Fusion;* **22**: No. 12, 1597-1612(Dec 1982).

The instability strength of a diverted plasma with vertical elongation is measured for a range of the magnetic-field decay index, $-1.5 < n < +0.5$, in the standard-D and inverted-D configurations. The range of the instability growth time is from one to four orders of magnitude greater than previously published results. When the plasma current is in the range of 170-310 kA, the instability can be suppressed by passive stabilization due to currents induced in a discrete coil system together with a moderate-power (100 kW) active feedback system. The inverted-D configuration is three times more unstable than the standard-D configuration for the same ellipticity. The inverted-D configuration is destabilized by its negative triangularity and the standard-D is stabilized by its positive triangularity.

30940 **Viscoresistive ballooning and density fluctuations in the ZT-40 device.** Dagazian, R.Y.; Paris, R.B. (Los Alamos National Lab., NM (USA)). *Nuclear Fusion;* **22**: No. 12, 1670-1674(Dec 1982).

Letter-to-the-editor.

Resistive ballooning subject to the effects of viscosity is put forward as a possible explanation for some of the observed density fluctuations in the ZT-40 device at Los Alamos.

30941 **8-Channel interferometer for the measurement of electron density profiles in a Tokamak plasma.** Behn, R.; Morgan, P.D. (Centre de Recherches en Physique des Plasmas, Lausanne (Switzerland)); Watterson, R.L. (Massachusetts Inst. of Tech., Cambridge (USA). Francis Bitter National Magnet Lab.). *Helvetica Physica Acta;* **55**: No. 2, 210(15 Nov 1982). (In German).

From Spring meeting of the Swiss Physical Society; Berne (Switzerland); Lyon (France) (2 Apr 1982).

Published in summary form only; meeting continued Lyon, 21 - 23 Aug 1982.

30942 **Atomic physics in tokamak plasmas.** Hinnov, E. (Princeton Univ., NJ (USA). Plasma Physics Lab.). *Nuclear Instruments and Methods in Physics Research;* **202**: No. 1/2, 381-391(1 Nov 1982).

From 6. international conference on fast ion beam spectroscopy; Quebec (Canada) (17 - 20 Aug 1981).

With 39 refs.

Tokamak discharges produce hydrogen-isotope plasmas in a quasi-steady state, with radial electron temperature, Tsub(e)(r), and density nsub(e)(r), distribution usually centrally peaked, with typical values Tsub(e)(0) approx.= 1 - 3 keV, nsub(e)(r) approx.= 10^{14} cm^{-3}. Besides hydrogen, the plasma contains small quantities of carbon, oxygen, various construction or wall-conditioning materials such as Fe, Cr, Ni, Ti, Zr, Mo, and perhaps elements added for special diagnostic purposes, e.g., Si, Sc, Al, or noble gases. These elements are spatially fairly homogeneously distributed, with the different ionization states occurring near radial locations where Tsub(e)(r) approx.= Esub(i), the ionization potential. Thus, spectroscopic measurements of various plasma properties, such as ion temperatures, plasma motions or oscillations, radial transport rates, etc. are automatically endowed with spatial resolution. Furthermore the emitted spectra, even of heavier elements such as Fe or Ni, are fairly simple because only the ground levels are appreciably populated under the prevailing plasma conditions. Identification of near-ground transitions, including particularly magnetic dipole and intercombination transitions of ions with ionization potentials in the several keV range, and determination of their collisional and radiative transition probabilities will be required for development of appropriate diagnostics of tokamak-type plasma approaching the prospective fusion reactor conditions.

30943 **Studies of conceptual spheromak fusion reactors.** Katsurai, M.; Yamada, M. (Princeton Univ., NJ (USA). Plasma Physics Lab.). *Nuclear Fusion;* **22**: No. 11, 1407-1419(Nov 1982).

Paper copy only, copy does not permit microfiche production3 refs.

Preliminary design studies are carried out for a spheromak fusion reactor. Simplified circuit theory is applied to obtain the characteristic relations among various parameters of the spheromak configuration for an aspect ratio of A >or approx. 1.6. These relations are used to calculate the parameters for the conceptual designs of three types of fusion reactor: (1) the DT reactor with two-component-type operation, (2) the ignited DT reactor, and (3) the ignited catalysed-type DD reactor. With a total wall loading of approx. 4 $MW.m^{-2}$, it is found that edge magnetic fields of only approx. 4 T (DT) and approx. 9 T (Cat. DD) are required for ignited reactors of 1 m plasma (minor) radius with output powers in the

gigawatt range. An assessment of various schemes of generation, compression and translation of spheromak plasmas is presented.

30944 **Irradiation uniformity of spherical heavy-ion-driven ICF targets.** Sacks, R.A. (Science Applications Inc., Oakbrook, IL (USA)); Arnold, R.C.; Magelssen, G.R. (Argonne National Lab., IL (USA)). *Nuclear Fusion;* **22**: No. 11, 1421-1431(Nov 1982).

Estimates are presented for non-uniformity of energy deposition in spherical-shell ICF targets driven by beams of high-energy heavy ions. The principal consideration is shown to be the difference in penetration depth of ions entering at different angles relative to the surface of the sphere. Calculations are reported for 12-, 20-, and 32-beam symmetrical illumination. A rough assessment of required implosion symmetry indicates that a trade-off will exist between target gain and number of beams. A brief discussion of possible angular pressure-smoothing mechanisms is included.

30945 **Field-reversed configurations with a component of energetic particles.** Finn, J.M. (Naval Research Lab., Washington, DC (USA)); Sudan, R.N. (Cornell Univ., Ithaca, NY (USA). Lab. of Plasma Studies). *Nuclear Fusion;* **22**: No. 11, 1443-1518(Nov 1982).

Microfiche only, copy does not permit paper copy reproduction24 refs.

This review is concerned with the physics of field-reversed configurations created by energetic particles of large orbits, of which the earliest example is the Astron. The Astron concept has evolved into the Ion Ring Compressor in which a low-energy ring of ions is magnetically compressed to high energy for heating the confined plasma to thermonuclear ignition. A third version is the hybrid in which field reversal is created both by plasma currents as in a theta-pinch or a spheromak and a component of energetic large orbit ions to provide heating energy as well as improved stability. This paper treats first the injection, trapping, and formation of electron and ion rings from a theoretical standpoint as well as presenting the principal experimental results. The equilibria and the characteristics of the particle orbits are discussed in some detail including conditions under which the orbits cease to be integrable and pass to a stochastic description. The theory of magnetic compression of rings and the classical transport of heat and particles of the plasma confined in the closed-poloidal-field-line region is presented. The bulk of the review is concerned with low-frequency stability of such configurations by means of a generalized energy principle for treating the large-orbit particles in the Vlasov limit. The pathology of all possible unstable modes is discussed at some length. We conclude with an exhaustive survey of micro-instabilities driven by the energetic particle current for a special model and conclude that most of them are stabilized by strong gradients in density and magnetic field. A brief discussion on drift modes follows. Our present theoretical understanding of these systems, although still incomplete in some respects, nevertheless leads to the view that the promise of the very favourable features of fusion reactors based on these concepts is a sufficient impetus for their continued experimental and theoretical study.

30946 **Leakage of runaway electrons from tokamaks.** Wong, K.L. (Princeton Univ., NJ (USA). Plasma Physics Lab.). *Nuclear Fusion;* **22**: No. 11, 1528-1531(Nov 1982).

Letter-to-the-editor.

Runaway electron orbits are calculated in a tokamak magnetic field. It is shown that these electrons tend to drift towards a larger major radius with a velocity vsub(R)-vector = qcE/B_0R-circumflex. This effect may be relevant to some recent experimental observations in tokamaks, namely, the correlation between the loop voltage and the hard-X-ray flux in lower-hybrid-wave current-drive experiments and the exceptionally long plasma life-time in a low-density, low-loop-voltage tokamak discharge.

30947 **Volt-second analysis and consumption in Doublet III plasmas.** Ejima, S.; Callis, R.W.; Luxon, J.L.; Stambaugh, R.D.; Taylor, T.S.; Wesley, J.C. (General Atomic Co., San Diego, CA (USA)). *Nuclear Fusion;* **22**: No. 10, 1313-1319(Oct 1982).

A Poynting's Theorem method is used for evaluating the volt-second consumption in a tokamak discharge. The method accurately identifies the inductive and resistive components of the volt-second consumption, and allows both quantities to be determined from magnetic measurements made outside the plasma. Only simple computational techniques are required. Application of the method to typical Doublet III near-circular plasmas (R = 1.43 m, a = 0.44 m, b/a approx.= 1.2) indicates that the flux at the plasma surface required to establish the current flat-top is 2.0 +- 0.2 V.s/MA. Approximately 40% of this flux is consumed in resistive dissipation. This division between resistive and inductive flux differs significantly from that obtained using an alternative data analysis method in which the resistive loss is evaluated at the plasma axis. The reasons for the difference are discussed.

30948 **Mechanical divertor experiments in Macrotor.** Talmadge, S.; Conn, R.W.; Prinja, A.K.; Taylor, R.J. (Center for Plasma Physics and Fusion Engineering, University of California, Los Angeles (USA)). *Nuclear Fusion;* **22**: No. 10, 1369-1372(Oct 1982).

Letter-to-the-editor.

The feasibility of pumped limiters has been demonstrated on the Macrotor tokamak using both small neutral collection probes (2.5 cm diameter) and a large-area limiter (20 cm x 60 cm). Neutral pressures due to particle accumulation have reached as high as 8 microns. The particle removal efficiency of the neutral collection probes was measured to be 17% and estimated to be greater than 50% in the large-area limiter case. A quadratic dependence of the pressure on plasma density is observed.

30949 **Surface modification to waveguides.** Timberlake, J.R.; Ruzic, D.N.; Moore, R.L.; Cohen, S.A.; Manos, D.M. US Patent Application 6-388,873. 16 Jun 1982. 10p. Contract AC02-76CH03073.

A method is described for treating the interior surfaces of a waveguide to improve power transmission comprising the steps of mechanically polishing to remove surface protrusions; electropolishing to remove embedded particles; ultrasonically cleaning to remove any residue; coating the interior waveguide surfaces with an alkyd resin solution or electrophoretically depositing carbon lamp black suspended in an alkyd resin solution to form a 1μ to 5μ thick film; vacuum pyrolyzing the film to form a uniform adherent carbon coating.

30950 **Status of PBFA.** Cook, D.L. (Princeton University, Plasma Physics Laboratory, P.O. Box 451, Princeton, NJ 08544). *Transactions of the American Nuclear Society;* **41**: 164(Jun 1982). (CONF-820609—).

From American Nuclear Society annual meeting; Los Angeles, CA, USA (6 Jun 1982).

30951 **Lawrence Livermore National laboratory tandem mirror program.** Fowler, T.K. (Lawrence Livermore National Laboratory, P.O. Box 808, Livermore, CA 94550). *Transactions of the American Nuclear Society;* **41**: 163(Jun 1982). (CONF-820609—).

From American Nuclear Society annual meeting; Los Angeles, CA, USA (6 Jun 1982).

30952 **PLT and PDX results.** Okabayashi, M. (Princeton University, Plasma Physics Laboratory, P.O. Box 451, Princeton, NJ 08544). *Transactions of the American Nuclear Society;* **41**: 163(Jun 1982). (CONF-820609—).

From American Nuclear Society annual meeting; Los Angeles, CA, USA (6 Jun 1982).

30953 **The Lawrence Livermore National laboratory inertial fusion program.** Holzrichter, J.F. (Lawrence Livermore National Laboratory, P.O. Box 808, Livermore, CA 94550). *Transactions of the American Nuclear Society;* **41**: 164(Jun 1982). (CONF-820609—).

From American Nuclear Society annual meeting; Los Angeles, CA, USA (6 Jun 1982).

30954 **Improved ion source.** Leung, K.N.; Ehlers, K.W. US Patent Application 6-374,847. 4 May 1982. 21p. Contract W-7405-ENG-48.

A magnetic filter for an ion source reduces the production of undesired ion species and improves the ion beam quality. High-energy ionizing electrons are confined by the magnetic filter to an ion source region, where the high-energy electrons ionize gas molecules. One embodiment of the magnetic filter uses permanent magnets oriented to establish a magnetic field transverse to the direction of travel of ions from the ion source region to the ion extraction region. In another embodiment, low energy 16 eV electrons are injected into the ion source to dissociate gas molecules and undesired ion species into desired ion species,

30955 **Mirror fusion test facility: magnet cyrogenics.** VanSant, J.H. (Lawrence Livermore National Lab., Univ. of California, Livermore, CA). *Advances in Cryogenic Engineering;* **27**: 557-564(1982). (CONF-810835—).

From 1981 cryogenic engineering conference; San Diego, CA, USA (10 Aug 1981).

The design of the Mirror Fusion Test Facility is described and illustrated, with the magnet, vacuum vessel, and the LHe flow system diagramed. Magnet cooling and thermal protection are described. The cryogenic system is described with a sectional view of the magnet coil illustrated, showing its construction and thermal shields. The design current and Joule heating rate are less than the specified maxima; the expected heat load on the magnet is also less than allowed. Cool-down and warm-up will not develop undesirable stresses. The specific cryogenic performance is yet to be evaluated.

30956 **Gaseous saturable absorbers for the Helios CO_2 laser system.** Haglund, R.F. Jr.; Nowak, A.V.; Czuchlewski, S.J. (Los Alamos National Lab., NM). *IEEE (Institute of Electrical and Electronics Engineers) Journal of Quantum Electronics;* **QE-17**: No. 9, 1799-1808(Sep 1981).

Saturable absorbers are widely used to suppress parasitic oscillations in large-aperture, high-power CO_2 fusion-laser systems. We report experimental results on SF_6-based gaseous saturable absorbers used for parasitic suppression in the eight-beam, 10 kJ Helios fusion-laser system. The gas mix effectively quenches self-lasing in the 9 and 10 μm branches of the CO_2 laser spectrum while simultaneously allowing high transmission of subnanosecond multiwavelength pulses for target-irradiation experiments. The gas isolator now in use consists of SF_6 and the additional fluorocarbons: 1, 1-difluoroethane (FC-152a); dichlorodifluoromethane (FC-12); chloropentafluoroethane (FC-115); 1,1-dichloro 2,2-difluoroethylene (FC-1112a); chlorotrifluoroethylene (FC-1113); and perfluorocyclobutane (FC-C318). The saturation of the mix was studied as a function of incident fluence, pressure, cell length, and incident wavelength. Experimental results are presented on the saturation properties of pure SF_6 and FC-152a and compared with the saturation behavior of CO_2 at 400°C.

30957 **Accelerator development for heavy ion fusion.** Talbert, W.L. Jr.; Sawyer, G.A. (Los Alamos Scientific Lab., NM). *IEEE (Institute of Electrical and Electronics Engineers) Transactions on Nuclear Science;* **NS-28**: No. 2, 1331-1334(Apr 1981).

Accelerator technology development is presented for heavy ion drivers used in inertial-confinement fusion. The program includes construction of low-velocity test-bed accelerator facilities, development of analytical and experimental techniques to characterize ion-beam behavior, and the study of ion-beam energy deposition.

30958 **Progress in inertial fusion research at Los Alamos Scientific Laboratory.** Perkins, R.B. (Los Alamos Scientific Lab., NM (USA)). pp 3-11 of Plasma physics and controlled nuclear fusion research 1980. Proceedings of the eighth international conference held by the IAEA in Brussels, 1-10 July 1980. Vienna, Austria; International Atomic Energy Agency (1981).

From 8. international conference on plasma physics and controlled nuclear fusion research; Brussels, Belgium (1 Jul 1980).

The Los Alamos Scientific Laboratory Inertial Confinement Fusion Program is reviewed. Experiments using the Helios CO_2 laser system delivering up to 6kJ on target are described. Because breakeven energy estimates for laser drivers of 1 μm and above have risen and there is a need for CO_2 experiments in the tens-of-kJ regime as soon as practical, a first phase of Antares construction is now directed toward completion of two of the six original modules in 1983. These modules are designed to deliver 40kJ of CO_2 laser light on target.

30959 **Starfire - a conceptual design of a commercial tokamak power plant.** Abdou, M.A.; Baker, C.C. (Argonne National Lab., IL (USA)); DeFreece, D.; Trachsel, C. (McDonnell Douglas Astronautics Co., St. Louis, MO (USA)); Graumann, D. (General Atomic Co., San Diego, CA (USA)); Kokoszenski, J. (Parsons (Ralph M.) Co., Pasadena, CA (USA)). pp 119-131 of Plasma physics and controlled nuclear fusion research 1980. Proceedings of the eighth international conference held by the IAEA in Brussels, 1-10 July 1980. Vienna, Austria; International Atomic Energy Agency (1981).

From 8. international conference on plasma physics and controlled nuclear fusion research; Brussels, Belgium (1 Jul 1980).

Starfire is a conceptual design for a commercial tokamak power plant based on the deuterium/tritium/lithium fuel cycle. The emphasis of the study is on the simplicity of the engineering design, maintainability, lower electricity cost, and improved safety and environmental features. The reactor has a 7-m major radius and produces 1200MW of electric power. Starfire operates in a steady-state mode with the plasma current driven by a lower-hybrid RF system. The plasma purity control and exhaust system is based on the limiter/vacuum concept, which offers unique advantages for commercial power reactors. The blanket utilizes a solid lithium compound for tritium breeding and pressurized water as the coolant.

30960 **Tandem mirror reactors with thermal barriers.** Logan, B.G.; Arfin, B.; Barr, W.L. (California Univ., Livermore (USA). Lawrence Livermore National Lab.). pp 133-141 of Plasma physics and controlled nuclear fusion research 1980. Proceedings of the eighth international conference held by the IAEA in Brussels, 1-10 July 1980. Vienna, Austria; International Atomic Energy Agency (1981).

From 8. international conference on plasma physics and controlled nuclear fusion research; Brussels, Belgium (1 Jul 1980).

Preliminary calculations of Q and magnet designs are presented for three different versions of tandem mirror reactors (TMR) using thermal barriers to enhance plug potentials by auxiliary electron heating. These three versions, called A-cell-barrier TMR, axisymmetric-barrier TMR, and inside-barrier TMR, exhibit reduced plug density ($nsub(p) << 10^{19} m^{-3}$) and less required magnetic mirror field (Bsub(mirror) approximately 9T) compared to TMR designs without thermal barriers. A-cell barrier TMR Q's range from 5 to 25 depending on the central-cell length (Lsub(c)=100 to 200m) and peak centre-cell beta βsub(c)(0.3 to 0.7) allowed by MHD stability. Axisymmetric-barrier TMR Q's range from 14 at Lsub(c)=100m to 30 at Lsub(c)=200m, if peak βsub(c)=1. From a global equilibrium model for the inside-barrier TMR, Q values greater than 15 are achieved for nu=0.5 in the modified Boltzmann relation for the plug potential. Even higher Q's are obtained by using ECRF heating in the barrier to create a hot, mirror-trapped electron population. TMR's buring D-D as a fuel have been analysed with a modified version of the global-equilibrium model and under the assumption of an axisymmetric plug and barrier stabilized by surface magnetic fields. High-barrier mirror ratio is now feasible (Rsub(b)=30-50), and short barrier length permits Qsub(DD) values greater than 5.

30961 **Laser fusion studies at Naval Research Laboratory.** McMahon, J.; Orens, J.; Bodner, S. (Naval Research Lab., Washington, DC (USA)). pp 227-238 of Plasma physics and controlled nuclear fusion research 1980. Proceedings of the eighth international conference held by the IAEA in Brussels, 1-10 July 1980. Vienna, Austria; International Atomic Energy Agency (1981).

From 8. international conference on plasma physics and controlled nuclear fusion research; Brussels, Belgium (1 Jul 1980).

The NRL group is studying the technical feasibility of high-gain laser fusion pellets driven by low irradiance ($< 10^{14} W.cm^{-2}$) multinanosecond lasers. In earlier experiments it was shown that both absorption and hydrodynamic efficiencies were consistent with

high-gain pellet designs. In addition to extending this work to greater intensities and larger spot sizes, research is under way on the origins and magnitude of target preheating at low irradiance, on experimental and theoretical work on the issue of symmetry and into the related questions of Rayleigh-Taylor instability and mixing of layers in multilayer targets. Substantial progress has been made in all of these areas: the rear surfaces of slab targets have been ablatively accelerated to velocities above $10^7 cm.s^{-1}$ with acceptably low levels of preheat, and there is experimental evidence of smoothing of spatial non-uniformities in the laser profile on a transverse scale of 100μm or less.

30962 **Interaction of short-wavelength laser radiation with spherical-shell targets.** Slater, D.C.; Berger, R.L.; Busch, G.E. (KMS Fusion, Inc., Ann Arbor, MI (USA)). pp 249-260 of Plasma physics and controlled nuclear fusion research 1980. Proceedings of the eighth international conference held by the IAEA in Brussels, 1-10 July 1980. Vienna, Austria; International Atomic Energy Agency (1981).

From 8. international conference on plasma physics and controlled nuclear fusion research; Brussels, Belgium (1 Jul 1980).

Laser-plasma interaction experiments have been performed at both 1.05μm and 0.53μm. Measurements of absorption and X-ray production from spherical-shell targets have shown significant differences between the two laser wavelengths. The laser power on target up to 0.7-TW at 0.53μm was sufficient to observe effects from a high-temperature corona and confirmed the earlier predictions for wavelength scaling of the hot-electron temperature.

30963 **Simplified poloidal divertor experiments in Doublet III.** Nagami, M.; Fujisawa, N.; Ioki, K. (Japan Atomic Energy Research Inst., Tokai, Ibaraki. Tokai Research Establishment). pp 367-380 of Plasma physics and controlled nuclear fusion research 1980. Proceedings of the eighth international conference held by the IAEA in Brussels, 1-10 July 1980. Vienna, Austria; International Atomic Energy Agency (1981).

From 8. international conference on plasma physics and controlled nuclear fusion research; Brussels, Belgium (1 Jul 1980).

Experimental results are reported on a single null poloidal divertor and on an expanded boundary configuration produced in the upper half of the Doublet III vacuum vessel. In the single null poloidal divertor (Part 1), a line-averaged plasma density of up to $8x10^{13} cm^{-3}$ was obtained. Without employing any particular divertor chamber, this simple divertor reduced the accumulation of metallic impurities and radiative power loss in the main plasma and improved the energy confinement time. The plasma density in the divertor region increased non-linearly with the increase of the main plasma density. This was associated with a strong concentration of hydrogen recycling in the divertor region. High-density discharges also provided condensed radiative cooling in the divertor region, i.e. high-density diverted discharges realize remote radiative cooling. In the expanded boundary configuration (Part 2), the diverted flux was expanded by more than a factor of ten before reaching the vessel wall. The central radiative power falls by an order of magnitude and a significant amount (approximately 50%) of the Ohmic power was radiated in the expanded boundary region. Comparison of discharges with and without the expanded boundary showed: (1) reduction of the influx of nickel and oxygen impurities by an order of magnitude; (2) reduction of the influx of injected argon by a similar factor; and (3) that the concentration of argon in a non-diverted plasma was reduced by a factor of 10 when the expanded boundary was turned on.

30964 **Progress at NRL and Cornell in light ion beam research for inertial-confinement fusion.** Cooperstein, G.; Goldstein, S.A.; Mosher, D. (Naval Research Lab., Washington, DC (USA)). pp 401-411 of Plasma physics and controlled nuclear fusion research 1980. Proceedings of the eighth international conference held by the IAEA in Brussels, 1-10 July 1980. Vienna, Austria; International Atomic Energy Agency (1981).

From 8. international conference on plasma physics and controlled nuclear fusion research; Brussels, Belgium (1 Jul 1980).

Proof-of-principle and scaling experiments for light-ion-driven inertial-confinement fusion are in progress at NRL. Important advances have been made in the areas of ion production with pinch-reflex diodes and of beam focusing and transport. At Cornell, light-ion beams of Li^{+1}, B^{+1} and C^{+1} have been produced and work on producing low-divergence ion beams has progressed.

30965 **Progress toward fusion with light ions.** Kuswa, G.W. (Sandia National Labs., Albuquerque, NM (USA)). pp 413-421 of Plasma physics and controlled nuclear fusion research 1980. Proceedings of the eighth international conference held by the IAEA in Brussels, 1-10 July 1980. Vienna, Austria; International Atomic Energy Agency (1981).

From 8. international conference on plasma physics and controlled nuclear fusion research; Brussels, Belgium (1 Jul 1980).

New results in target design, beam generation and transport, and pulse power technology have led to a programme shift stressing light-ion-driven inertial-confinement fusion. According to present estimates, a gain-ten fusion pellet will require at least 1MJ and approximately 100TW power input. Progress in ion sources has resulted in beam power density of approximately $1TW.cm^{-2}$, a factor of ten increase over the last year, and cylindrical implosion experiments have been performed. Other experiments have demonstrated the ability to transport ion and electron beams with high efficiency and have confirmed numerical predictions on the properties of beam transport channels converging at a target. These developments, together with improvements in pulse power technology, allow the projection that the 72-beam, 100-TW Particle Beam Fusion Accelerator, PBFA II, will attain target output energy equal to stored energy in the accelerator.

30966 **Argonne heavy-ion fusion program. Accelerator demonstration facility (phase zero).** Watson, J.M.; Arnold, R.C.; Bogaty, J.M. (Argonne National Lab., IL (USA)). pp 425-434 of Plasma physics and controlled nuclear fusion research 1980. Proceedings of the eighth international conference held by the IAEA in Brussels, 1-10 July 1980. Vienna, Austria; International Atomic Energy Agency (1981).

From 8. international conference on plasma physics and controlled nuclear fusion research; Brussels, Belgium (1 Jul 1980).

The feasibility of the RF linac heavy-ion driver for inertial-confinement fusion is generally now accepted. There are, however, many beam manipulations that are specific to the RF linac HIF driver which must be demonstrated. Accelerator projects have begun at Argonne National Laboratory (ANL) to resolve some of the uncertainties. A minimum programme has started which involves demonstration of some critical issues for linacs and accumulator rings (injection, accumulation, extraction, emittance growth, beam life-time, internal compression, etc.). An improved facility is also proposed which would deposit more than 3kJ on a 0.5-mm-radius spot for interesting energy deposition experiments. The experimental programme during the past two years has developed a high-intensity xenon source, a 1.5-MV pre-accelerator, and the initial RF linac cavities for the demonstration projects.

30967 **Fusion applications of the MEQALAC.** Maschke, A.W. (Brookhaven National Lab., Upton, NY (USA)). pp 435-436 of Plasma physics and controlled nuclear fusion research 1980. Proceedings of the eighth international conference held by the IAEA in Brussels, 1-10 July 1980. Vienna, Austria; International Atomic Energy Agency (1981).

From 8. international conference on plasma physics and controlled nuclear fusion research; Brussels, Belgium (1 Jul 1980).

Published in summary form only.

30968 **Multi-megajoule heavy-ion induction linacs.** Faltens, A.; Hoyer, E.; Keefe, D.; Laslett, L.J.; Smith, L. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.); Bangerter, R.O. (California Univ., Livermore (USA). Lawrence Livermore National Lab.); Herrmannsfeldt, W.B. (Stanford Univ., CA (USA)). pp 437-445 of Plasma physics and controlled nuclear fusion research 1980. Proceedings of the eighth international conference held by the IAEA in Brussels, 1-10 July 1980. Vienna, Austria; International Atomic Energy Agency (1981).

From 8. international conference on plasma physics and controlled nuclear fusion research; Brussels, Belgium (1 Jul 1980).

One of the most promising Inertial Confinement Fusion (ICF) igniter concepts is the heavy-ion induction linac system. A driver providing a beam of heavy ions has the potential advantages of a short ion range in the target material, a very large power transport capability, and the ability to produce high power densities at distances of 5-10m from the final lens elements required in a power-producing reactor. Many driver configurations are possible, and it has been generally found that the driver would be the dominant cost item in a power plant. Some preliminary results obtained from a design and cost optimization computer program for an ion induction linac accelerator are presented. An estimate of the effect of ICF system cost on the cost of generated electricity is made.

30969 **Neutral-beam injector research and development at ORNL and LBL/LLL in the USA.** Barber, G.C.; Blue, C.W.; Dagenhart, W.K. (Oak Ridge National Lab., TN (USA)). pp 449-456 of Plasma physics and controlled nuclear fusion research 1980. Proceedings of the eighth international conference held by the IAEA in Brussels, 1-10 July 1980. Vienna, Austria; International Atomic Energy Agency (1981).

From 8. international conference on plasma physics and controlled nuclear fusion research; Brussels, Belgium (1 Jul 1980).

Neutral-beam injectors have been developed and applied successfully for injection heating of PLT and ISX-B plasmas. Present and near-future injection systems for PDX, ISX-C, DIII, MFTF and TFTR are similar in principle, although scaled in beam energy, current and pulse width to meet the machine requirements. In addition, as shown in recent calculations, an INTOR or ETF device will also utilize a positive-ion-based system with possible trade-offs between beam energy, current and pulse length, i.e. beam energies of about 100keV are acceptable if the current and/or pulse length may be increased to appropriate values. Recent direct energy recovery experiments have shown that a positive-ion-based system can be expected to operate at an overall system efficiency of up to 50% if the beam energy is limited to a value below 75keV/nucleon. For injection energy above 200keV, a negative-ion-based neutral-beam injector may be needed. The performance highlights are reported of the existing ORNL and LBL/LLL beam systems and the necessary R and D needs for future high-efficiency, long-pulse beam systems.

30970 **Development of superconducting magnets for use in nuclear fusion machines.** Haubenreich, P.N.; Lubell, M.S. (Oak Ridge National Lab., TN (USA)); Cornish, D.N. (California Univ., Livermore (USA). Lawrence Livermore National Lab.); Beard, D.S. (Department of Energy, Washington, DC (USA). Office of Fusion Energy). pp 467-469 of Plasma physics and controlled nuclear fusion research 1980. Proceedings of the eighth international conference held by the IAEA in Brussels, 1-10 July 1980. Vienna, Austria; International Atomic Energy Agency (1981).

From 8. international conference on plasma physics and controlled nuclear fusion research; Brussels, Belgium (1 Jul 1980).

A brief summary is given of current efforts and future plans in development of superconducting magnets for tokamaks and mirror fusion devices.

30971 **Development of tritium technology for United States magnetic fusion energy programme.** Anderson, J.L. (Los Alamos Scientific Lab., NM (USA)); Wilkes, W.R. (Monsanto Research Corp., Miamisburg, OH (USA). Mound Facility); Maroni, V.A. (Argonne National Lab., IL (USA)). pp 471-478 of Plasma physics and controlled nuclear fusion research 1980. Proceedings of the eighth international conference held by the IAEA in Brussels, 1-10 July 1980. Vienna, Austria; International Atomic Energy Agency (1981).

From 8. international conference on plasma physics and controlled nuclear fusion research; Brussels, Belgium (1 Jul 1980).

Tritium technology development for the US Department of Energy fusion programme is taking place principally at three laboratories, Mound Facility, Argonne National Laboratory and Los Alamos Scientific Laboratory. The paper reviews the major points of each of the three programmes and looks at aspects of the tritium technology being developed at other laboratories within the USA. Facilities and experiments to be discussed include (a) the Tritium Effluent Control Laboratory and the Tritium Storage and Delivery System for the Tokamak Fusion Test Reactor at Mount Facility, (b) the Lithium Processing Test Loop and the solid breeder blanket studies at Argonne, and (c) the Tritium Systems Test Assembly at Los Alamos.

30972 **Plasma heating by a wide ksub(parallel)-spectrum waveguide system in the ion cyclotron range of frequencies.** Ono, M.; Stix, T.H.; Wong, K.L.; Horton, R. (Princeton Univ., NJ (USA). Plasma Physics Lab.). pp 501-503 of Plasma physics and controlled nuclear fusion research 1980. Proceedings of the eighth international conference held by the IAEA in Brussels, 1-10 July 1980. Vienna, Austria; International Atomic Energy Agency (1981).

From 8. international conference on plasma physics and controlled nuclear fusion research; Brussels, Belgium (1 Jul 1980).

A reactor-heating concept utilizing a wave-guide-launched ion-Bernstein wave in the ion-cyclotron range of frequencies is presented. Details of wave-launching transformation, propagation and absorption, together with low-power experimental results from the ACT-1 toroidal device, are summarized.

30973 **Lower-hybrid heating and current drive in tokamaks and related experiments.** Porkolab, M.; Schuss, J.J.; Takase, Y. (Massachusetts Inst. of Tech., Cambridge (USA). Francis Bitter National Magnet Lab.). pp 507-514 of Plasma physics and controlled nuclear fusion research 1980. Proceedings of the eighth international conference held by the IAEA in Brussels, 1-10 July 1980. Vienna, Austria; International Atomic Energy Agency (1981).

From 8. international conference on plasma physics and controlled nuclear fusion research; Brussels, Belgium (1 Jul 1980).

Experimental results on waveguide-plasma coupling and RF heating in the vicinity of the lower-hybrid frequency in the M.I.T. Alcator-A and in Versator II tokamaks are reported. The forthcoming Alcator-C lower-hybrid heating experimental parameters are summarized. From Princeton results on several small-scale experiments, related to waveguide-plasma coupling (H-1) and RF current drive (ACT-1), are presented, as well as recent theoretical investigations of efficient RF current generation using lower-hybrid waves or Alfven waves.

30974 **Scope and status of the USA Engineering Test Facility including relevant TFTR research and development.** Becraft, W.R. (Oak Ridge National Lab., TN (USA)); Reardon, P.J. (Princeton Univ., NJ (USA). Plasma Physics Lab.). pp 563-573 of Plasma physics and controlled nuclear fusion research 1980. Proceedings of the eighth international conference held by the IAEA in Brussels, 1-10 July 1980. Vienna, Austria; International Atomic Energy Agency (1981).

From 8. international conference on plasma physics and controlled nuclear fusion research; Brussels, Belgium (1 Jul 1980).

The vehicle by which the fusion programme would move into the engineering testing phase of fusion power development is designated the Engineering Test Facility (ETF). The progress toward the design and construction of the ETF will reflect the significant achievements of past, present, and future experimental tokamak devices. Some of the features of this foundation of experimental results and relevant engineering designs and operation will derive from the Tokamak Fusion Test Reactor (TFTR) Project, now nearing the completion of its construction phase. The ETF would provide a test-bed for reactor components in the fusion environment. To initiate preliminary planning for the ETF decision, the Office of Fusion Energy (OFE) established the ETF Design Center activity to prepare the design of the ETF. This paper describes the design status of the ETF and discusses some highlights of the TFTR R and D work.

30975 **Alternative fusion fuel cycle research.** Conn, R.W.; Shuy, G.W. (California Univ., Los Angeles (USA). School of Engineering and Applied Science); Kerst, D. (Wisconsin Univ., Madison (USA)). pp 621-630 of Plasma physics and controlled nuclear fusion research 1980. Proceedings of the eighth international conference held by the IAEA in Brussels, 1-10 July 1980. Vienna, Austria; International Atomic Energy Agency (1981).

From 8. international conference on plasma physics and controlled nuclear fusion research; Brussels, Belgium (1 Jul 1980).

New effects, including nuclear elastic scattering, reaction propagation, and self-interaction between energetic ions promoted from the bulk Maxwellian, are found to increase the reactivity of alternate fuel cycle mixtures. The effects are more pronounced at high electron temperature (>50keV) typical of cycles from D-D to p-^{11}B. Superconducting coil designs for octupole configurations can be designed to operate in the low neutron environment of an alternate fuel cycle reactor and stable, levitated octupole configurations have been found in which the external coils provide stabilization without influencing the equilibrium. Studies of D-D reactors indicate that the tritium inventory can be 15 times lower than an equivalent power D-T device. For catalysed D-D systems, the reduction is 100 and for D-^{3}He it is about 1000. Little difference is found in overall fuel handling and vacuum system costs. Reactors with D-^{3}He may result in 10 to 100 times less radiation dose in a possible accident scenario compared to D-T systems but D-D reactors may actually generate higher external doses. Finally, reactor scenarios are studied which involve generator reactors which produce ^{3}He from a semi-catalysed D-D unit to be burned in satellite reactors located nearer the user.

30976 **LASL Fast Liner Experiment.** Sherwood, A.R.; Cantrell, E.L.; Henins, I.; Hoida, H.W.; Jarboe, T.R.; Malone, R.C.; Marshall, J. (Los Alamos Scientific Lab., NM (USA)). pp 691-698 of Plasma physics and controlled nuclear fusion research 1980. Proceedings of the eighth international conference held by the IAEA in Brussels, 1-10 July 1980. Vienna, Austria; International Atomic Energy Agency (1981).

From 8. international conference on plasma physics and controlled nuclear fusion research; Brussels, Belgium (1 Jul 1980).

The LASL Fast Liner Experiment explored a fusion concept in which a suitably prepared plasma is adiabatically compressed to thermonuclear temperatures and densities by a rapidly imploding solid metal liner. A prepared plasma having $\beta > 1$ is in contact with the liner and end plugs, and contains an embedded magnetic field to inhibit thermal conduction. Cylindrical liners are magnetically imploded by a large axial current carried in the liner shell. The experimental work to develop this concept involved attempts to provide a suitable plasma for liner implosions and studies of magnetically driven liner implosions. In the plasma preparation experiments, a coaxial plasma gun was used to inject plasma into a simulated liner geometry. About 2μs after plasma injection a density of $3x10^{16}cm^{-3}$, a temperature of 40eV, and an embedded azimuthal field of 10kG were measured. In the implosion studies, cylindrical aluminium liners were imploded by Z-pinch currents of 10-15MA. Symmetrical implosions having velocities in the range 4-$6x10^5cm.s^{-1}$ have been obtained for liners with typical initial dimensions of 10cm length, 5cm diameter and 1mm thickness using a 1.8-MJ capacitor bank. Implosion velocities of $9-10x10^5cm.s^{-1}$ were observed for 6-cm-long, 5.6-cm-diameter, 1-mm-thick liners driven by a 2.4-MJ bank. In each case, current drive to the liner was maintained until the liner converged on the axis. The observed velocities and trajectories agree well with the predictions of a one-dimensional code, CHAMISA.

30977 **Stimulated-Brillouin-scattering studies in low-density plasmas using microwave sources.** Mase, A.; Luhmann, N.C.; Holt, J. Jr.; Huey, H.; Rhodes, M. (California Univ., Los Angeles (USA)); Di Vergilio, W.F.; Thomson, J.J. (TRW, Inc., Redondo Beach, CA (USA)); Randall, C.J. (Lawrence Livermore National Lab., CA (USA)). pp 745-758 of Plasma physics and controlled nuclear fusion research 1980. Proceedings of the eighth international conference held by the IAEA in Brussels, 1-10 July 1980. Vienna, Austria; International Atomic Energy Agency (1981).

From 8. international conference on plasma physics and controlled nuclear fusion research; Brussels, Belgium (1 Jul 1980).

Observations of stimulated Brillouin scattering (SBS) in microwave interaction with a plasma, as verified by the satisfaction of the frequency and wavelength matching rules and growth rate, are presented. A small amount of chamber reflectivity causes ion fluctuations due to the standing-wave ponderomotive force, which then serve as an enhanced noise level for the initiation of the instability. Saturation of the backscatter is observed and compared with existing theories. The control of SBS using finite-bandwidth comb-type or random-noise-type pumps is also reported.

30978 **Plasma physics and controlled nuclear fusion research 1980. Proceedings of the eighth international conference held by the IAEA in Brussels, 1010, July 1980.** Vienna, Austria; International Atomic Energy Agency (1981). vp. (CONF-800707—Vol.2).

From 8. international conference on plasma physics and controlled nuclear fusion research; Brussels, Belgium (1 Jul 1980).

Abstracts for each paper were entered into the data base. (MOW)

30979 **Effect of nonlinear refraction on beam brightness in laser fusion applications.** Phipps, C.R. Jr.; Thomas, S.J.; Watkins, D.E. (Scientific Lab., Los Alamos, NM). *Proceedings of the International Conference on Lasers;* 878-888(1979).

The far-field brightness loss due to nonlinear refraction of a laser beam of finite transverse extent is a limitation for phase conjugation. We present exact calculations, supported by measurements, for these effects in Gaussian beams.

99 GENERAL AND MISCELLANEOUS

9901 Management

REFER ALSO TO CITATION(S) 29745

30980 **(LA-UR—83-475) Los Alamos science. Volume 4, No. 7.** Cooper, N.G. (ed.). (Los Alamos National Lab., NM (USA)). Win-Spr 1983. Contract W-7405-ENG-36. 198p. NTIS, PC A09/MF A01. Order Number DE83010523.

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A history of the Los Alamos National Laboratory over its 40 years is presented. The evolution of the laboratory is broken down into the Oppenheimer years, the Bradbury years, the Agnew years and the Kerr years. The weapons program is described including nuclear data, early reactors, computing and computers, plutonium, criticality, weapon design and field testing.

30981 **(JPRS—83178) China report: science and technology, No. 193.** (Joint Publications Research Service, Arlington, VA (USA)). 1 Apr 1983. C; Chinese articles. 20p. NTIS.

The report includes brief articles on proposed measures for reform of science education system, and successful tests of China's first proton linear accelerator. Abstracts are included for developments in automotive engineering, mechanical engineering, mineralogy, optics, power engineering, printing technology, scientific instrumentation, and thermophysics. (GHT)

9902 Mathematics And Computers

REFER ALSO TO CITATION(S) 29732, 29899, 29984, 29985, 30195, 30283, 30284, 30285, 30790

30982 **(AECL—6076(Rev.C)) AELIB user's manual.** Evans, L.E.; Klawitter, G.L. (eds.). (Atomic Energy of Canada Ltd., Chalk River, Ontario. Chalk River Nuclear Labs.). May 1981. 543p. NTIS (US Sales Only), PC A23/MF A01. Order Number DE83700416.

This report is an updatable manual for users of AELIB, the AECL Library of FORTRAN-callable routines for the CRNL

CDC 6600/CYBER 170 system. It provides general advice on the use of this library and detailed information on the selection and usage of particular library routines.

30983 **(AECL—7428) Sampling from the normal and exponential distributions.** Chaplin, K.R.; Wills, C.A. (Atomic Energy of Canada Ltd., Chalk River, Ontario. Chalk River Nuclear Labs.). Jan 1982. 48p. NTIS (US Sales Only), PC A03/MF A01. Order Number DE83700417.

Methods for generating random numbers from the normal and exponential distributions are described. These involve dividing each function into subregions, and for each of these developing a method of sampling usually based on an acceptance rejection technique. When sampling from the normal or exponential distribution, each subregion provides the required random value with probability equal to the ratio of its area to the total area. Procedures written in FORTRAN for the CYBER 175/CDC 6600 system are provided to implement the two algorithms.

30984 **(BDX—613-2941) Software quality assurance.** Moody, S.D. (Bendix Corp., Kansas City, MO (USA)). Mar 1983. Contract AC04-76DP00613. 22p. NTIS, PC A02/MF A01. Order Number DE83010520.

The merits of SQA practices over the entire life cycle of the software product can be summarized as follows: more reliable product, lower life cycle costs, early exposure of life cycle inconsistencies, and early exposure of design errors. A guideline for the development of a Software Quality Assurance Program has been drafted. Topics critical to the development of a Software Quality Assurance Program are discussed.

30985 **(BNL—32831) SOCLIR: a system for optimal control of linear regulators.** Schaedler, J.; Anandalingam, G. (Brookhaven National Lab., Upton, NY (USA)). Mar 1983. Contract AC02-76CH00016. 46p. NTIS MF A01. Order Number DE83010881.

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SOCLIR is a software package for optimally controlling the output of a system to follow idealized time-paths. It provides a time sequence of control (policy) solutions that would regulate the system over time at minimum deviation. The linear regulator problem forms a special class of optimal control problems which is also called linear quadratic tracking problem; the system to be regulated is approximated by a linear model and both positive and negative deviations from the ideal time-path is penalized symmetrically in a quadratic cost function. The cost function also includes a cost attached to controlling the system. The theory is given in detail in the next section.

30986 **(CONF-830447—1) Implications of recent research on human factors for teachers of computing skills.** Gabriel, J.R. (Argonne National Lab., IL (USA)). 1983. Contract W-31-109-ENG-38. 7p. NTIS, PC A02/MF A01. Order Number DE83010713.

From Workshop on small computers; Atlanta, GA, USA (3 Apr 1983).

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Recent studies of people at work have produced a classification of their activity applicable to the history of education and to teaching itself. These insights suggest ways to teach computing and to build an innovative program to integrate schools and colleges with local industry to the benefit of all three.

30987 **(CONF-8105212—1) Quantum mechanical Hamiltonian models of discrete processes that erase their own histories: application to Turing machines.** Benioff, P.A. (Argonne National Lab., IL (USA)). 1981. Contract W-31-109-ENG-38. 41p. NTIS, PC A03/MF A01. Order Number DE83010584.

From Physics of computation conference; Cambridge, MA, USA (6 May 1981).

Work done before on the construction of quantum mechanical Hamiltonian models of Turing machines and general descrete processes is extended here to include processes which erase their own histories. The models consist of three phases, the forward process phase in which a map T is iterated and a history of iterations is generated, a copy phase which is activated if and only if T reaches a fix point, and an erase phase which erases the iteration history, undoes the iterations of T and recovers the initial state except for the copy system. A ballast system is used to stop the evolution at the desired state. The general model so constructed is applied to Turing machines. The main changes are that the system undergoing the evolution corresponding to T iterations becomes three systems corresponding to the internal machine, the computation tape, and computation head. Also the copy phase becomes more complex since it is desired that this correspond also to a copying Turing machine.

30988 **(CONF-8108158—1) Array-processing features in the next Fortran.** Smith, B.T. (Argonne National Lab., IL (USA)). 1981. Contract W-31-109-ENG-38. 16p. NTIS, PC A02/MF A01. Order Number DE83009009.

From Conference on relationship between numerical computation and programming languages; Boulder, CO, USA (3 Aug 1981).

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This paper summarizes the array-processing facilities being proposed for the next Fortran standard by the Fortran Standard's committee X3J3. The facilities include: automatic arrays; element-by-element array operations; array expressions; new conditional control constructs for logical arrays; and a large collection of new intrinsics for arrays. The paper concludes with a comparison of the Fortran facilities with the ALGOL68-TORRIX68 system for computations in linear vector spaces.

30989 **(CONF-8206178—1) Solving open questions with an automated theorem-proving program.** Wos, L. (Argonne National Lab., IL (USA)). 1982. Contract W-31-109-ENG-38. 39p. NTIS, PC A03/MF A01. Order Number DE83008686.

From 6. CADE conference on automated deduction; New York, NY, USA (1 Jun 1982).

The primary objective of this paper is to demonstrate the feasibility of using an automated theorem-proving program as an automated reasoning assistant. Such usage is not merely a matter of conjecture. As evidence, we cite a number of open questions which were solved with the aid of a theorem-proving program. The open questions are taken from studies of ternary boolean algebra, finite semigroups, equivalential calculus, and the design of digital circuits. Despite the variety of successes, no doubt there still exists many who are very skeptical of the value of automating any form of deep reasoning. It is the nature of this skepticism which brings us to the second objective of the paper. The secondary objective is that of dispelling, at least in part, some of the resistance to such automation. To do this, we discuss two myths which form the basis for the inaccurate evaluation of both the usefulness and the potential of automated theorem proving. Rejection of the two myths removes an important obstacle to assigning to an automated theorem-proving program its proper role - the role of colleague and assistant.

30990 **(CONF-8206178—2) Procedure implementation through demodulation and related tricks.** Winker, S.K.; Wos, L. (Argonne National Lab., IL (USA)). 1982. Contract W-31-109-ENG-38. 32p. NTIS, PC A03/MF A01. Order Number DE83010578.

From 6. CADE conference on automated deduction; New York, NY, USA (1 Jun 1982).

There are many common tasks which are dispatched by the computer programmer by means of procedures or subroutines. These tasks range from simple bookkeeping and updating to the seeking of the generalization of two given formulas. The corresponding procedures, or their equivalent, are often needed to complete some activity being performed by an automated theorem-proving program. Such procedures may appear to be either very cumbersome for an automated theorem-proving program or even beyond the capacity of such a program. In this paper we give examples that show that neither is the case. Demodulation is the key to implementing the procedures which accomplish such common tasks. We give here sets of demodulators for accomplishing a wide variety of tasks. The first given demodulator set enables the program to find the least general subsumer of two given unit clauses.

We then turn our attention to questions of counting and classifying, bookkeeping and updating, and cleanup after case analysis. Finally, we give a set of demodulators for coping with set-theory in a natural way. The material contained here is a sample of the additional possibilities for the use of demodulation and for automated theorem proving in general. It turns out that demodulation is even more powerful than was realized with its uses for both simplification and canonicalization.

30991 **(DOE/EI/10682—T1) Time-staged linear programs. Technical report SOL 80-28.** Dantzig, G.B. (Stanford Univ., CA (USA). Systems Optimization Lab.). Oct 1980. Contract AT03-80EI10682;AT03-76ER72018. 27p. NTIS, PC A03/MF A01. Order Number DE83010110.

The paper outlines some procedures for solving time-staged (staircase) linear programs. Two approaches are discussed: the first based on modifying the block structure of the basis so that there are square non-singular sub-blocks along the diagonal; and the second based on the nested decomposition principle except applied to the dual system instead of the primal as proposed by Glassey and by Manne and Ho.

30992 **(DOE/ER/02383—0087) General purpose PDP-11 interface processor.** Purtilo, J. (Illinois Univ., Urbana (USA). Dept. of Computer Science). Oct 1982. Contract AC02-76ER02383. 37p. (COO—2383-0087). NTIS, PC A03/MF A01. Order Number DE83009574.

The Z80 interface card, which for simplicity we refer to as the Zcard, is a general purpose microprocessor which is directly interfaced to the Whaley multiplexor, itself implemented on PDP-11 series computers at the University of Illinois. The Zcard provides two serial ports at EAI interface levels and contains up to 16K of local memory. The principle function of the Zcard is to serve as an interface in which the user might alter protocols, change interface characteristics (e.g. baud rate, hardware echo, or flow control), or switch between synchronous and asynchronous modes all under software control. In addition, the Zcard provides extra lines for control of external devices (e.g. modem) and input of status data. In the simpliest use, the Zcard runs a program, downloaded from the PDP-11, which emulates the level EIAFB card (previously developed for the Whaley Multiplexor) for serial communication with terminals. Using no flow control, Zcard performance seems superior to that of the EIAFB card in that no characters are lost under normal use (due to the much larger buffer which the Zcard can provide). The Zcard can further distinguish itself from the EIAFB card in that flow control can be enabled by software. A more sophisticated application of the Zcard might include linking several Zcards (using a synchronous option and both of the provided ports) into a network. In this capacity, a ring topology suggests itself as the most immediate choice, although many alternate connection schemes can be envisioned. This report is intended to summarize the project as well as provide an outline for those intending to modify or program the Zcard.

30993 **(HMI—376) HMI scientific report 1981.** (Hahn-Meitner-Institut fuer Kernforschung Berlin G.m.b.H. (Germany, F.R.). Bereich Datenverarbeitung und Elektronik). 1982. 224p. (In German). Available from Fachinformationszentrum Energie, Physik, Mathematik, Karlsruhe (Germany, F.R.).

In the HMI data pocessing and electronics department, besides the general service activities, several research- and development projects are under way: Computer systems. Numerical and applied mathematics. Software development. Process computer systems - hardware. Nuclear electronics, techniques for measurement and control. Research on electronic devices and irradiation tests. Central data processing. Collaboration with the BERNET project of the Wissenschaftliches Rechenzentrum Berlin (WRB).

30994 **(IKE—6-EUR-2) EURLIB data adjustment to integral experiments. 2. progress report.** Baechle, R.D.; Hehn, G.; Kicherer, G. (Stuttgart Univ. (Germany, F.R.). Inst. fuer Kernenergetik und Energiesysteme). Sep 1981. 22p. Available from Fachinformationszentrum Energie, Physik, Mathematik, Karlsruhe (Germany, F.R.).

The 'global detector version' of the data adjustment code ADJUST-EUR has been completed and the code is in test. The lay-out of the programme is shown and a description of various subroutines are given. In the global detector concept all detector measurements are taken together in one adjoint calculation, so that the calculation effort is reduced appreciably. The total adjoint source may be weighted sum of detector responses, in order to get similar sensitivity profiles, compared with the demand of power reactor shielding. The evaluation of the ASPIS experiment has been started with ANISN and DOT calculations. Since only one-dimensional ANISN runs can be used in the iterative adjustment procedure, the transversal leakage must be included by buckling factors, derived from DOT results. The comparison between one- and two-dimensional results shows, that we have to consider variations of the buckling factor in energy and in space, where the local dependence is the larger effect. This means, that the iron block has to be subdivided into several material regions with different buckling corrections.

30995 **(JAERI-M—9605) Model for calculating the optimal replacement interval of computer systems.** Fujii, M.; Asai, K. (Japan Atomic Energy Research Inst., Tokyo). Aug 1981. 51p. (In Japanese). NTIS (US Sales Only), PC A04/MF A01. Order Number DE83701504.

A mathematical model for calculating the optimal replacement interval of computer systems is described. This model is made to estimate the best economical interval of computer replacement when computing demand, cost and performance of computer, etc. are known. The computing demand is assumed to monotonously increase every year. Four kinds of models are described. In the model 1, a computer system is represented by only a central processing unit (CPU) and all the computing demand is to be processed on the present computer until the next replacement. On the other hand in the model 2, the excessive demand is admitted and may be transferred to other computing center and processed costly there. In the model 3, the computer system is represented by a CPU, memories (MEM) and input/output devices (I/O) and it must process all the demand. Model 4 is same as model 3, but the excessive demand is admitted to be processed in other center. (1) Computing demand at the JAERI, (2) conformity of Grosch's law for the recent computers, (3) replacement cost of computer systems, etc. are also described.

30996 **(JINR—10-82-84) GRANAS system for graphic analysis of nuclear spectrometrical data.** Brudanin, V.B.; Bulla, G.; Bulla, F.; Vylov, Ts.; Medved', S.V. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Problems). 1982. 6p. (In Russian). NTIS (US Sales Only), PC A02/MF A01. Order Number DE83700423.

An interactive display system for graphic analysis of spectrometrical data by means of the EC-1040 computer and a videoterminal consisting of the KRS 4201 computer, GD-71 graphical display and EC 7054 graphical device are described. The system solves the following problems: represents apparatus spectra of nuclear radiations graphically by means of EC 7054 graphical device; makes ready starting approximated data for spectral line processing with special programs; performs graphical analysis of experimental spectra using GD-71 graphical display.

30997 **(ORNL/CSD—114) Numerical methods for large sparse linear least-squared problems.** Heath, M.T. (Oak Ridge National Lab., TN (USA)). Apr 1983. Contract W-7405-ENG-26. 23p. NTIS, PC A02/MF A01. Order Number DE83011062.

Large sparse least squares problems arise in many applications, including geodetic network adjustments and finite element structural analysis. Although geodesists and engineers have been solving such problems for years, it is only relatively recently that numerical analysts have turned attention to them. In this paper we present a survey of numerical methods for large sparse linear least squares problems, focusing mainly on developments since the last comprehensive surveys of the subject published in 1976. We consider direct methods based on elimination and on orthogonalization, as well as various iterative methods. The ramifications of rank deficiency, constraints, and updating are also discussed.

30998 (SAND—80-1654/2) Addendum to network analysis planning for project management: a Primer. Cronin, E. (Sandia National Labs., Albuquerque, NM (USA)). Mar 1983. Contract AC04-76DP00789. 21p. NTIS, PC A02/MF A01. Order Number DE83010214.

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This brochure is an Addendum to SAND80-1652. I have broken down into minute detail the different computer reports without repeating the instructions given in the Primer. The computer printouts that I deal with are textual and graphic. I am assuming that you are familiar with the network format and techniques described in the Primer, and this additional information will help you decide which reports may be of use to you. The main reports have already been described in the Primer; this addendum lists all possible reports and gives some examples to help you understand the format. After the textual are presented, I list alternatives available with the computer graphic reports. All computer graphic reports are plotted by an activity's expected completion date. Individual options for each computer graphic are listed so that you can select the one that fills your particular needs.

30999 (SAND—83-0085) Combinatorial optimization with Boolean constraints. Hulme, B.L.; Worrell, R.B. (Sandia National Labs., Albuquerque, NM (USA)). Feb 1983. Contract AC04-76DP00789. 24p. NTIS, PC A02/MF A01. Order Number DE83010387.

This report shows how Boolean algebraic formula manipulation can be used to solve certain kinds of optimization problems. If the problem can be formulated in terms of 0 to 1 variables and if the feasible solutions can be described by a Boolean equation, then the method of this report can be used. The method generates feasible solutions algebraically as terms of a disjunctive normal form of a Boolean function. Many small sample problems are solved to illustrate the method and the practical situations in which these optimization problems arise.

31000 (SAND—83-0091) ALPLASMA (aluminum plasma) and XRAD (x-radiation) computer program abstract. Iwan, D.C. (Sandia National Labs., Albuquerque, NM (USA)). Mar 1983. Contract AC04-76DP00789. 8p. NTIS, PC A02/MF A01. Order Number DE83008697.

Program ALPLASMA models the ion densities and K-shell x-radiation for a homogeneous, isothermal, isodense aluminum plasma. Program XRAD produces data for a spectral plot of the K-shell emission from the output of ALPLASMA. Both programs are designed for interactive use on a Digital Equipment Corporation VAX. However, all modeling is done under the control of the subroutine ALPLAS so that the computational model can be lifted away intact from the interactive main line. Only a few statements in the codes are other than ANSII Standard Fortran 77.

31001 (SAND—83-0464) GRAPH: an interactive digitizing and plotting program. Selleck, C.B. (Sandia National Labs., Albuquerque, NM (USA)). Mar 1983. Contract AC04-76DP00789. 67p. NTIS, PC A04/MF A01. Order Number DE83009702.

GRAPH is an interactive program that allows the user to achieve two objectives. The first is digitizing graphs or plots to create data files of points. The second is the inverse of the first: plotting graphs from data files onto a graphics device. The program has extensive internal help and is designed to allow the user to get results quickly and easily. It is written in RATFOR and is intended for use on a VAX computer. The program provides graphical output through all of the Sandia Virtual Device Interface (VDI) graphics devices.

31002 (SAND—83-0515) Global error estimates for ODEs based on extrapolation methods. Shampine, L.F.; Baca, L.S. (Sandia National Labs., Albuquerque, NM (USA)). Mar 1983. Contract AC04-76DP00789. 30p. NTIS, PC A02/MF A01. Order Number DE83010415.

It is shown how to exploit the powerful codes based on extrapolation of the midpoint rule so as to solve the initial value problem for a system of ordinary differential equations (ODEs) and to provide estimates of the global (true) error in the solution values. Particular attention is given to the reliability of the estimates and to the overall efficiency of the integration.

31003 (SAND—83-0732C) Extensions to the sparse matrix technique for automatic test generation. Acken, C.F. (Sandia National Labs., Albuquerque, NM (USA)). 1983. Contract AC04-76DP00789. 5p. (CONF-830344—1). NTIS, PC A02/MF A01. Order Number DE83010029.

From Automatic test generation workshop; San Francisco, CA, USA (15 Mar 1983).

This paper presents additional insight into the modeling of digital systems using a sparse matrix formulation. The set of primitives used in the original formulation of the matrix model is expanded to include CMOS transmission-gate configurations. The matrix model can be used to generate tests using the path sensitization approach. A covering approach for path selection and the use of testability measures in guiding test generation are discussed. A data structure for storing the sparse matrix to perform path sensitization is suggested. Two nonclassical approaches to ATG are proposed as research items.

31004 (UCID—19767) NLS: a system identification package for transient signals. Description and user's manual. Goodman, D.M. (Lawrence Livermore National Lab., CA (USA)). Mar 1983. Contract W-7405-ENG-48. 50p. NTIS, PC A03/MF A01. Order Number DE83009509.

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NLS is a system identification package designed specifically for determining difference-equation models for systems whose inputs and outputs are transients. In its present from the code is available only for a VAX 11/780 using the VMS operating system, but transporting it to a different system should not be difficult. I emphasize that this document is a preliminary edition describing a preliminary version of NLS. The purpose of this manual is to show potential users how to run NLS intelligently; it is not intended to be a treatise on system identification. We describe the particular methods used by NLS, but the user must be able to decide for himself if these methods apply to his particular problems. Much of the manual is devoted to explaining the various optimization methods employed by NLS so that the user will be able to select the parameters which control their behavior.

31005 (UCID—19779) Computer-aided engineering in NESD. Ames, H.S. (Lawrence Livermore National Lab., CA (USA)). 13 Apr 1983. Contract W-7405-ENG-48. 28p. NTIS, PC A03/MF A01. Order Number DE83011260.

To meet the challenge of developing increasingly complex electronic systems in the face of tighter budget constraints and manpower shortages, NESD, in conjunction with other divisions and the EE Department, has started to develop a computer-aided engineering (CAE) capability. Simply stated, the goal of CAE is to help engineers improve their productivity by using computers. The use of computers in engineering is certainly not new, but the widespread availability of computer resources will allow engineers to utilize computers for all facets of their work, including modeling and analyses, design, documentation, project management, software development, and communications.

31006 (UCRL—88958) Interactive tools for data exploration. Bly, S.A. (Lawrence Livermore National Lab., CA (USA)). 1983. Contract W-7405-ENG-48. 7p. (CONF-830324—4). NTIS, PC A02/MF A01. Order Number DE83009848.

From 15. symposium on the interface of computer science and statistics; Houston, TX, USA (16 Mar 1983).

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In complex data problems involving unknown structures and relationships, techniques which help analysts find features and characteristics of the data are particularly important. These techniques are useful predecessors to formal analysis methods. Computers have provided computational power to make a wide variety of such techniques available for data exploration. A computing facility with locator input, color graphics output, and audio output offers the basis for interactive data presentation tools. One such tool uses visual and aural representations of data to give the analyst a variety

of perspectives of the data. By combining user interactivity with various data output techniques, the analyst can dynamically explore complex data sets looking for patterns, structures, relationships, and features. With application to example data sets, this tool illustrates a means of data exploration.

31007 **(UIUCDCS-R—82-1103) ODE methods for the solution of differential/algebraic systems.** Gear, C.W.; Petzold, L.R. (Illinois Univ., Urbana (USA). Dept. of Computer Science). Sep 1982. Contract AC02-76ER02383. 57p. (COO—2383-0086; UILU-ENG—82-1727). NTIS, PC A04/MF A01. Order Number DE83010114.

In this paper we study the numerical solution of the differential/algebraic systems $F(t, y, y') = 0$. Many of these systems can be solved conveniently and economically using a range of ODE methods. Others can be solved only by a small subset of ODE methods, and still others present insurmountable difficulty for all current ODE methods. We examine the first two groups of problems and indicate which methods we believe to be best for them. Then we explore the properties of the third group which cause the methods to fail. We describe a reduction technique which allows systems to be reduced to ones that can be solved. It also provides a tool for the analytical study of the structure of systems.

31008 **(UIUCDCS-R—82-1116) Root finding in simulation and ODE solution.** Gear, C.W. (Illinois Univ., Urbana (USA). Dept. of Computer Science). Dec 1982. Contract AC02-76ER02383. 12p. (UILU-ENG—82-1743; COO—2383-0091). NTIS, PC A02/MF A01. Order Number DE83010995.

A simple implementation of an interpolation scheme for detecting a zero crossing of a sequence of function values is described. This has applications in continuous simulation and other situations involving integration in which a discontinuity or termiantion is triggered by the change of sign of a switching function and it is necessary to determine a close approximation to the value of time at which this change occurs. This technique has been coded in FORTRAN.

31009 **Maximum power signal restoration.** Trussell, H.J. (Los Alamos Scientific Lab., NM). *IEEE (Institute of Electrical and Electronics Engineers) Transactions on Acoustics, Speech and Signal Processing;* **ASSP-29**: No. 5, 1059-1061(Oct 1981). Contract W-7405-ENG-36.

A new method of signal restoration is presented for applications where the signal is a sparse, positive series of delta functions. The method is defined by solving the constrained maximization problem: maximize f/sup T/f subject to $f \geqq 0$ and $(g - Hf)^2 = (n)^2$. An algorithm to obtain the solution to this problem is given. Results are shown that demonstrate the successful application of this method.

31010 **One-dimensional random walk with phase transition.** Percus, O.E.; Percus, J.K. (New York Univ., New York). *SIAM (Society for Industrial and Applied Mathematics) Journal on Applied Mathematics;* **40**: No. 3, 485-497(Jun 1981). Contract AC02-76ER03077.

A random walk on a one-dimensional lattice is considered. The walk is asymmetric but with different asymmetry on the right and left halves of the line. As the parameter space describing the two asymmetries is covered, several qualitatively different distributions result: limiting distribution, unimodal diffusion and biomodal diffusion. The corresponding parameter space phase boundaries are obtained, as well as the precise form of the distributions.

31011 **Nested partitioning procedure for numerical multiple integration.** Friedman, J.H. (Stanford Linear Accelerator Center, CA); Wright, M.H. *ACM Transactions on Mathematical Software;* **7**: No. 1, 76-92(Mar 1981). Contract AC03-76SF00515;AM03-76SF00326.

An algorithm is presented for adaptively partitioning a multidimensional coordinate space on the basis of optimization of a scalar function of the coordinates. The goal is to construct a set of hyperrectangular regions, such that the variation of function values within each region is small. These regions are then used as the basis for a stratified sampling estimate of the definite integral of the function.

31012 **Graphics software: from techniques to principles.** Hatfield, L. (Lawrence Livermore National Lab., CA); Herzog, B. *Proceedings of the SID;* **22**: No. 2, 87-102(1981). Contract W-7405-ENG-48.

The development of graphics software is traced by considering important events in three areas. First, the development of techniques in graphics is examined by reviewing both a number of early applications and the principles and software that evolved from these applications. Second, the importance of algorithms is discussed. Historically important algorithms and current research areas are briefly outlined. Finally, the recent quest for standards in graphics software is examined. The history, major driving forces, and status of this quest are reviewed.

31013 **Set of staircase linear programming test problems.** Ho, J.K. (Brookhaven National Lab., Upton, NY); Loute, E. *Mathematical Programming;* **20**: 245-250(1981). Contract AC02-76CH00016.

A set of staircase linear programming test problems are made available for computational experiments.

9903 Information Handling

REFER ALSO TO CITATION(S) 30993

31014 **(CONF-8110265—1) National Energy Software Center: what it is and what it has to offer.** Legan, M. (Argonne National Lab., IL (USA)). 1981. Contract W-31-109-ENG-38. 7p. NTIS, PC A02/MF A01. Order Number DE83008947.

From American Society of Civil Engineers fall meeting; St. Louis, MO, USA (26 Oct 1981).

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The National Energy Software Center, or NESC, is a software exchange and information center operated by Argonne National Laboratory for the US Department of Energy (DOE) and the Nuclear Regulatory Commission (NRC). Its major objectives are (1) promoting the sharing of computer software among agency offices and contractors to eliminate duplication of effort and unnecessary expenditures, (2) facilitating the transfer of computer applications and technology to the information processing community, and (3) arranging for software exchange with other government agencies and coordinating for DOE the acquisition of non-government software.

31015 **(DOE/TIC—4500(Rev.71)) Standard distribution for unclassified scientific and technical reports.** Nelson, R.N. (ed.). (Department of Energy, Oak Ridge, TN (USA). Technical Information Center). Mar 1983. 28p. NTIS, PC A03/MF A01. Order Number DE83005965.

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31016 **(IAEA-TA—1854) Information services. Report to the Government of Peru.** Lasbo, P. (International Atomic Energy Agency, Vienna (Austria)). Jan 1982. 29p. NTIS (US Sales Only), PC A03/MF A01. Order Number DE83701525.

At the request of the Government of Peru an IAEA staff member undertook an expert assignment to the Instituto Peruano de Energia Nuclear (IPEN) within the framework of a technical assistance project. The purpose of the expert's travel was to evaluate a request for equipment for and consultant's advice on the establishment of library and information services and to advise IPEN staff

on the establishment of the services. The report presents the findings on the present level and future need for library and information services and presents a proposal for the further development of these.

31017 **(UCRL—88736) On-line entry and analysis of computer center operations logs.** Frobose, R.H.; Wilgus, C.A. (Lawrence Livermore National Lab., CA (USA)). 1983. Contract W-7405-ENG-48. 11p. (CONF-830536—1). NTIS, PC A02/MF A01. Order Number DE83010613.

From Aesop operations managers' conference; Las Vegas, NV, USA (4 May 1983).

This paper describes the CLARET system (Computer Logging and RETrieval) developed at Lawrence Livermore National Laboratory to gather computer center operations information directly into an on-line data base. This system replaces a manual logging system with its attendant problems of illegibility and lack of standardization. Much attention has been devoted to the design of the data entry phase in order to make it both natural to use and yet sufficiently strict to ensure that the information complies with data base requirements. The resulting marriage between a highly interactive, screen-oriented front end and a data base system has provided the dual benefits of more complete information and greater flexibility in using that information. Distribution of the information has been similarly improved since not only are the logs automatically printed for normal distribution, but they can also be viewed from remote terminals both while in progress and after completion. Finally, the resultant data base is available to any computer user for viewing and analysis.

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The notations in the final parentheses indicate the type of document, e.g., R for Report; the country of publication, e.g., US; and the language if other than English, e.g., In German. Tables of document types and country of publication codes appear after the indexes.

The title may be supplemented with additional words, or a phrase, if it appears additional information would be helpful. In cases for which the title contains little or no information related to the subject entry, it may be replaced entirely by the supplementary information. A qualifier is not always required, and in such cases the title will follow the unqualified subject descriptor.

The descriptors selected for use as subject terms are generally the names of specific materials, things, or processes. To the extent possible, a qualifier is selected to describe the properties of, or processes applied to, the subject term.

Index entries are selected to indicate the important ideas and concepts presented in a document, rather than words that may appear in the text. Within the available thesaurus terms, the most probable or logical place to look for typical information is selected. "See references" are included to guide users from synonymous terms or phrases to the descriptor selected as a subject heading for the concept. (e.g. Pipeline Quality Gas see HIGH BTU GAS). "See also references" are used to indicate where to find references to subject concepts that are narrower, broader, or related to a particular subject heading. To complete an exhaustive search of a given subject, all such headings should be reviewed. Copies of DOE/TIC-7000, the Subject Thesaurus, are available from the National Technical Information Service (NTIS), U. S. Department of Commerce, Springfield, VA 22161.

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AC02-82ER53140	**Grumman Aerospace Corp., Princeton, NJ (USA)**	
	8:30850	DOE/ER/53140—7
AC02-83ER40085	**Tufts Univ., Medford, MA (USA)**	
	8:30669	DOE/ER/40085—1
AC03-76ET12056		
	8:29018	Society of Petroleum Engineers of A.I.M.E. (American Institute of Mining, Metallurgical an
AC03-76ET20000	**California Inst. of Tech., Pasadena (USA)**	
	8:29302	DOE/ET/20000—T5
AC03-76SF00098	**Lawrence Berkeley Lab., CA (USA)**	
	8:29248	NUREG/CR—3062
	8:29289	LBL—14220
	8:29317	LBL—15752
	Terra Tek, Inc., Salt Lake City, UT (USA)	
	8:29445	LBL—14605
	Lawrence Berkeley Lab., CA (USA)	
	8:29787	LBL—15716
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	8:29806	LBL—14509
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	8:30811	Journal of Physical Chemistry 86 NO. 24. 4668-4674 (25 Nov 1982).
AC03-76SF00515	**Stanford Linear Accelerator Center, CA (USA)**	
	8:30242	SLAC-PUB—3082
	8:30250	CAPE—2817([nd]).
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AC03-78ER01736	**Power Conversion Technology, Inc., San Diego, CA (USA)**	
	8:29795	DOE/ER/01736—T3
AC03-78SF02034	**Gas-Cooled Reactor Associates, La Jolla, CA (USA)**	
	8:29600	GCRA—82-001
	United Engineers and Constructors, Inc., Philadelphia, PA (USA)	
	8:29601	GCRA—82-005
	Gas-Cooled Reactor Associates, La Jolla, CA (USA)	
	8:29602	GCRA—82-006(Rev.1)
	8:29603	GCRA—82-013
	United Engineers and Constructors, Inc., Philadelphia, PA (USA)	
	8:29604	GCRA/UEC—82-007
	8:29605	GCRA/UEC—82-008
AC03-79ET14842	**Rockwell International Corp., Canoga Park, CA (USA). Rocketdyne Div.**	
	8:28799	DOE/ET/14842—T20

Contract No.	Abstract No.	Report No.
AC03-80ET34034	General Electric Co., Sunnyvale, CA (USA). Advanced Reactor Systems Dept.	
	8:29606	GEFR—00602-Vol.1
	8:29607	GEFR—00602-Vol.2
AC03-81SF11503	Radian Corp., Austin, TX (USA)	
	8:29464	DOE/SF/11503—1
AC04-76DP00053	Monsanto Research Corp., Miamisburg, OH (USA). Mound	
	8:29987	MLM—3057(OP)
	8:30108	
AC04-76DP00613	Bendix Corp., Kansas City, MO (USA)	
	8:30097	BDX—613-2924
	8:30984	BDX—613-2941
AC04-76DP00656		
	8:29723	
	8:30112	
	General Electric Co., St. Petersburg, FL (USA). Neutron Devices Dept.	
	8:30139	GEPP-TIS—681a
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	General Electric Co., St. Petersburg, FL (USA)	
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AC04-76DP00789	Sandia National Labs., Albuquerque, NM (USA)	
	8:28815	SAND—83-0410
	8:28993	SAND—82-1963
	8:29020	Society of Petroleum Engineers of A.I.M.E. (American Institute of Mining, Metallurgical an
	8:29057	SAND—82-2189
	8:29066	SAND—82-2965C
	8:29069	SAND—83-0828C
	8:29162	SAND—82-1069
	8:29163	SAND—82-2478
	8:29164	SAND—83-0450
	8:29253	SAND—83-0434
	8:29255	NUREG/CR—2422
	8:29258	SAND—82-1277
	8:29322	SAND—81-0135-Rev.2
	Acurex Corp., Mountain View, CA (USA)	
	8:29323	SAND—82-7125
	Boeing Computer Services Co., Seattle, WA (USA)	
	8:29340	SAND—81-7080/8
	8:29341	SAND—81-7085/18
	8:29342	SAND—81-7086/18
	8:29343	SAND—81-7087/8
	8:29344	SAND—81-7089/7
	8:29345	SAND—81-7089/8
	8:29346	SAND—81-7089/9
	8:29347	SAND—81-7089/10
	Battelle Columbus Labs., OH (USA)	
	8:29348	SAND—82-7126/1
	8:29349	SAND—82-7126/2
	Sandia National Labs., Albuquerque, NM (USA)	
	8:29350	SAND—83-0603
	8:29351	SAND—82-2248
	Sandia National Labs., Livermore, CA (USA)	
	8:29352	SAND—83-8005
	Sandia National Labs., Albuquerque, NM (USA)	
	8:29419	CONF-830316—2
	Budd Co., Fort Washington, PA (USA). Technical Center	
	8:29421	SAND—82-7039
	McDonnell Douglas Astronautics Co., Huntington Beach, CA (USA)	
	8:29422	SAND—82-7068/1
	Sandia National Labs., Albuquerque, NM (USA)	
	8:29428	SAND—83-0492
	8:29468	SAND—82-0863
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	Aluminum Co. of America, Alcoa Center, PA. Alcoa Labs.	
	8:29487	SAND—82-7113/1
	8:29488	SAND—82-7113/3
	Sandia National Labs., Albuquerque, NM (USA)	
	8:29686	NUREG/CR—2530
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	8:29719	SAND—83-6002(Mar 1983).
	8:29887	SAND—83-0435C
	8:29921	Surface Science 110 L599-L605 (1981).
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	8:29958	SAND—82-2796C
	8:29959	SAND—83-0825C
	8:30147	SAND—82-2362
	8:30241	SAND—83-0162
	8:30301	SAND—83-0823C
	8:30318	SAND—83-0770C
	8:30596	SAND—79-0271
	8:30597	SAND—83-0210
	8:30598	SAND—83-0461
	8:30925	SAND—83-0168
	8:30998	SAND—80-1654/2
	8:30999	SAND—83-0085
	8:31000	SAND—83-0091
	8:31001	SAND—83-0464
	8:31002	SAND—83-0515
	8:31003	SAND—83-0732C
AC04-76DP03533	Rockwell International Corp., Golden, CO (USA). Rocky Flats Plant	
	8:29158	RFP—3249
	8:29159	RFP—3372
	8:29160	RFP—3471
	8:30036	
	8:30111	
	8:30462	
AC04-76ET20254	Hughes Research Labs., Malibu, CA (USA)	
	8:29303	DOE/ET/20254—T1
AC04-76EV01013	Lovelace Biomedical and Environmental Research Inst., Albuquerque, NM	
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	8:30459	Toxicology and Applied Pharmacology 64 465-475 (1982).
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AC04-78CS35366	Purdue Univ., Lafayette, IN (USA). Heat Transfer Lab.	
	8:29418	ALO—5366-4
AC04-78ET13146	General Electric Co., Schenectady, NY (USA). Corporate Research and Development Dept.	
	8:30153	DOE/ET/13146—T1
	8:30154	DOE/ET/13146—T2

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	8:30155	DOE/ET/13146—T3
	8:30156	DOE/ET/13146—T4
	8:30157	DOE/ET/13146—T5
	8:30158	DOE/ET/13146—T6
	8:30159	DOE/ET/13146—T7
	8:30160	DOE/ET/13146—T8
	8:30161	DOE/ET/13146—T9
	8:30162	DOE/ET/13146—T10
	8:30163	DOE/ET/13146—T11
	8:30164	DOE/ET/13146—T12
AC04-81AL16320	Maxwell Labs., Inc., San Diego, CA (USA)	
	8:30146	MLR—1465
AC04-83AL22028	Teledyne Energy Systems, Timonium, MD (USA)	
	8:29284	DOE/AL/22028—T2
AC05-76OR00033	Oak Ridge Associated Universities, Inc., TN (USA)	
	8:28898	ORAU—210
	8:29765	ORAU/IEA—83-4(M)
AC05-80RA29353	Westinghouse Research and Development Center, Pittsburgh, PA (USA)	
	8:29498	DOE/RA/29353—1
AC06-76FF02170		
	8:29620	
AC06-76RL01830	Pacific Northwest Lab., Richland, WA (USA)	
	8:29117	PNL-SA—8508
	8:29247	NUREG/CR—3027
	8:29249	NUREG/CR—3124
	Bechtel National, Inc., San Francisco, CA (USA)	
	8:29250	ONWI—192
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	8:29330	Biomass 3 NO. 1. 43-57 (1983).
	Leeds and Northrup Co., North Wales, PA (USA)	
	8:29439	PNL—4613
	Pacific Northwest Lab., Richland, WA (USA)	
	8:29478	PNL-SA—10852
	Battelle Pacific Northwest Labs., Richland, WA (USA)	
	8:29482	EPRI-AP—2906
	AeroVironment, Inc., Pasadena, CA (USA)	
	8:29484	PNL—4572
	PB-KBB, Inc., Houston, TX (USA)	
	8:29517	PNL—4564
	Exxon Nuclear Co., Inc., Richland, WA (USA)	
	8:29540	DOE/ET/34215—32
	Battelle Pacific Northwest Labs., Richland, WA (USA)	
	8:29547	EPRI-NP—2960
	Pacific Northwest Lab., Richland, WA (USA)	
	8:29551	NUREG/CR—2956
	8:29685	NUREG/CR—2528
	TRC Environmental Consultants, Inc., Englewood, CO (USA)	
	8:29692	NUREG/CR—3149
	Energy Resource Management, Tucson, AZ (USA)	
	8:29703	PNL—4687
	Pacific Northwest Lab., Richland, WA (USA)	
	8:29855	PNL—4470
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	8:30294	PNL-SA—10888
	8:30317	NUREG/CR—3186
	8:30353	Northwest Science 56 NO. 1. 1-7 (1982).
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	Bechtel Group, Inc., San Francisco, CA (USA)	
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	Pacific Northwest Lab., Richland, WA (USA)	
	8:30496	PNL-SA—11049
	8:30522	Mutation Research 96 99-108 (1982).
	8:30556	Transactions of the American Fisheries Society 111 NO. 5. 624-637 (Sep 1982).
	8:30584	Bioelectromagnetics (New York) 3 341-347 (1982).
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AC06-76RL01831	Battelle Pacific Northwest Labs., Richland, WA	
	8:30341	Laboratory Animal Science 31 NO. 6. 717-720 (Dec 1981).
AC06-77RL01030	Rockwell International Corp., Richland, WA (USA). Rockwell Hanford Operations	
	8:29110	RHO-PB-SR—10-B-CP
	8:29161	RHO-BW-ST—38-P
	8:29988	RHO-SA—56
	Pacific Northwest Lab., Richland, WA (USA)	
	8:30595	RHO-BW-CR—133P
	Rockwell International Corp., Richland, WA (USA). Rockwell Hanford Operations	
	8:30603	RHO-BW-SA—205A-P
AC07-76ID01570	EG and G Idaho, Inc., Idaho Falls (USA)	
	8:29128	EGG-M—06183
	8:29295	IDO—10107-Vol.1
	8:29296	IDO—10107-Vol.2
	8:29558	EGG—2250
	8:29619	EGG-M—30182
	8:29640	EGG-M—02483
	8:29674	GEND—032
AC07-79ID12079	Utah Univ., Salt Lake City (USA). Research Inst.	
	8:29434	DOE/ID/12079—80
AC08-79ET27111	Teledyne Geotech, Garland, TX (USA)	
	8:29433	DOE/ET/27111—9
AC08-81DP40168	Avco-Everett Research Lab., Inc., Everett, MA (USA)	
	8:30891	DOE/DP/40168—1
AC08-82DP40152	KMS Fusion, Inc., Ann Arbor, MI (USA)	
	8:30906	KMSF-U—1263
AC09-76SR00001	Du Pont de Nemours (E.I.) and Co., Aiken, SC (USA). Savannah River Lab.	
	8:29126	DP—82-157-3
	8:29127	DP—1636
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	8:30363	DP—1644
AC11-76PN00014	Bettis Atomic Power Lab., West Mifflin, PA (USA)	
	8:29566	WAPD-MRP—159
	8:29616	
AC13-76GJ01664	Bendix Field Engineering Corp., Grand Junction, CO (USA). Grand Junction Operations	
	8:29096	GJBX—2(83)
AC19-79BC10069	Illinois Inst. of Tech., Chicago	
	8:29031	Society of Petroleum Engineers of A.I.M.E. (American Institute of Mining, Metallurgical an
AC21-76ET12138	West Virginia Univ., Morgantown (USA). Dept. of Geology and Geography	
	8:29058	DOE/ET/12138—1272
	8:29059	DOE/ET/12138—1343
	8:30587	DOE/ET/12138—1275
AC21-80ET14705	Stearns-Roger Corp., Denver, CO (USA)	
	8:28797	DOE/ET/14705—1394-Vol.1
	8:28798	DOE/ET/14705—1394-Vol.2
AC21-80MC14386	State Univ. of New York, Buffalo (USA). Dept. of Chemical Engineering	
	8:28801	DOE/MC/14386—1377

Contract No.	Abstract No.	Report No.
AC21-80MC14875	City Coll., New York (USA). Clean Fuels Inst.	
	8:29049	DOE/MC/14875—1373
AC21-81MC16000	Massachusetts Inst. of Tech., Cambridge (USA). Energy Lab.	
	8:28967	DOE/MC/16000—1294-Vol.1
AC21-81MC16219	Curtiss-Wright Corp., Wood-Ridge, NJ (USA). Power Systems Div.	
	8:28865	DOE/MC/16219—1403
AC21-82MC19146	Gruy Petroleum Technology, Inc., Houston, TX (USA)	
	8:29063	DOE/MC/19146—1400
AC22-80PC30123	United States Steel Corp., Monroeville, PA. Research Lab.	
	8:28888	DOE/PC/30123—T7
AC22-81PC40090	Mechanical Technology, Inc., Latham, NY (USA)	
	8:28813	MTI/WDC—82TR520
AI01-76ET20320	IIT Research Inst., Chicago, IL (USA)	
	8:29480	DOE/NASA/0182—1
	Massachusetts Inst. of Tech., Cambridge (USA). Aeroelastic and Structures Research Lab.	
	8:29481	DOE/NASA/3303—4
AI01-77ET10769	Gilbert Associates, Inc., Reading, PA (USA)	
	8:29780	DOE/NASA/0136—1
AI01-81FE00016	Foster-Miller, Inc., Waltham, MA (USA)	
	8:28887	DOE/FE/00016—T6
AI08-78ET44802	Geological Survey, Menlo Park, CA (USA)	
	8:30602	USGS-OFR—82-1041
AM03-76SF00326	Stanford Univ., CA	
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AM06-76RL02227	Battelle Pacific Northwest Labs., Richland, WA	
	8:30342	Atmospheric Environment 14 1013-1016 (1980).
AM21-78MC08216	Science Applications, Inc., Morgantown, WV (USA)	
	8:29060	DOE/MC/08216—1276
	8:29061	DOE/MC/08216—1380
AS02-78ET20512	Gulf Coast Research Lab., Ocean Springs, MS	
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AS04-78ET05369	New Mexico Inst. of Mining and Tech., Socorro	
	8:30350	New Mexico Journal of Science 21 NO. 2. 1-4 (Dec 1981).
AS05-76ER04047	Howard Univ., Washington, DC (USA). Dept. of Chemistry	
	8:30040	DOE/ER/04047—T1
AS05-79ER10418	Georgia State Univ., Atlanta (USA). Dept. of Physics and Astronomy	
	8:30759	DOE/ER/10418—T3
AS05-79ER10459	Louisiana State Univ., Baton Rouge	
	8:30883	Solid State Communications 39 993-995 (1981).
AS05-80ER10604	Texas Tech Univ., Lubbock	
	8:29995	Journal of Membrane Science 10 35-47 (1982).
AS05-80ER10720	Texas Univ., Austin (USA)	
	8:29287	DOE/ER/10720—6
AS05-82ER12052	Rice Univ., Houston, TX (USA)	
	8:29930	DOE/ER/12052—1
AS07-77ET28365	Colorado Geological Survey, Denver (USA)	
	8:29424	DOE/ET/28365—T3
AS09-76ER00688		
	8:30451	
AS09-76EV00637	Univ. of Georgia, Tifton	
	8:30436	Crop Science 22 NO. 4. 857-859 (Jul 1982).
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AS09-78SR01072	South Carolina Univ., Columbia (USA). Inst. of Archeology and Anthropology	
	8:30369	DOE/SR/01072—5
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	South Carolina Univ., Columbia (USA). Dept. of Geology	
	8:30588	DOE/SR/01072—8
AS19-80BC10310	New Mexico Inst. of Mining and Tech., Socorro	
	8:28988	Society of Petroleum Engineers of A.I.M.E. (American Institute of Mining, Metallurgical an
AS20-82LC10877	Wyoming Univ., Laramie (USA). Dept. of Civil Engineering	
	8:29072	DOE/LC/RI—83-5
AT03-76EI70052	Stanford Univ., CA (USA). Systems Optimization Lab.	
	8:29733	CONF-770549—2
	8:29739	DOE/EI/70052—T9
	8:29740	DOE/EI/70052—T10
	8:29741	DOE/EI/70052—T11
	8:29742	DOE/EI/70052—T12
	8:29753	DOE/EI/70052—T5
AT03-76ER70037	Stanford Univ., CA (USA). Board of Trustees	
	8:29877	DOE/ER/70037—T1
AT03-76ER70294	California Univ., Los Angeles (USA). Dept. of Materials Science and Engineering	
	8:29889	UCLA—34P290-3
AT03-76ER72018	Stanford Univ., CA (USA). Systems Optimization Lab.	
	8:29743	DOE/ER/72018—T4
	8:29744	DOE/ER/72018—T5
	8:29745	DOE/ER/72018—T6
	8:29746	DOE/ER/72018—T7
AT03-76ET35300	GA Technologies, Inc., San Diego, CA (USA)	
	8:29570	GA-A—15999
AT03-76ET35301	GA Technologies, Inc., San Diego, CA (USA)	
	8:29571	GA-A—16927
	8:29572	GA-A—16962
AT03-76ET51011	GA Technologies, Inc., San Diego, CA (USA)	
	8:30899	GA-A—16979
	8:30900	GA-A—17011
	8:30901	GA-A—17026
AT03-79EI10601	Stanford Univ., CA (USA). Systems Optimization Lab.	
	8:29734	DOE/EI/10601—T1
	8:29735	DOE/EI/10601—T2
	8:29736	DOE/EI/10601—T3
AT03-79ER10119	California Univ., Los Angeles (USA). Dept. of Earth and Space Sciences	
	8:30600	DOE/ER/10119—T4
AT03-80EI10682	Stanford Univ., CA (USA). Systems Optimization Lab.	
	8:30991	DOE/EI/10682—T1
AT03-80ER10673	California Univ., Los Angeles (USA). Dept. of Chemistry	
	8:28792	DOE/ER/10673—T1
	8:28793	DOE/ER/10673—T2
AT03-81SF11528	GA Technologies, Inc., San Diego, CA (USA)	
	8:29129	GA-A—17053
AT03-82ER60038	California Univ., Los Angeles (USA). Lab. of Biomedical and Environmental Sciences	
	8:30474	DOE/ER/60038—T1
AT03-82SF11642	Hawaii Univ., Honolulu (USA). Dept. of Meteorology	
	8:29479	UHMET—82-05
AT03-82SF11687	Rockwell International Corp., Canoga Park, CA (USA). Energy Systems Group	
	8:29593	ESG-DOE—13399

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AT21-80MC14394	West Virginia Univ., Morgantown (USA). Dept. of Geology and Geography	
	8:29062	DOE/MC/14394—1365
FC07-79ID12015	Arizona Univ., Tucson (USA). Bureau of Geology and Mineral Technology	
	8:29429	DOE/ID/12015—T1
FC07-80RA50272	Amherst Coll., MA (USA)	
	8:29435	DOE/RA/50272—T1
FC20-78LC10787	Geokinetics, Inc., Salt Lake City, UT (USA)	
	8:29067	DOE/LC/10787—109
FG01-80PR10108	National Association of Women Federal Contractors, Washington, DC (USA)	
	8:29732	DOE/PR/10108—2
FG01-80RA50302	Fort Smith, City of, AR (USA)	
	8:29850	DOE/RA/50302—1
FG01-80RA50339	Central Maine Power Co., Augusta (USA)	
	8:28809	DOE/RA/50339—1387-Vol.1
	8:28810	DOE/RA/50339—1387-Vol.2
FG01-80RA50366	EMCON Associates, San Jose, CA (USA)	
	8:29851	DOE/RA/50366—1
FG01-80RA50367	Metropolitan Service District, Portland, OR (USA)	
	8:29852	DOE/RA/50367—1
FG02-80CS40337	Chicago Dept. of Planning, IL (USA)	
	8:29847	DOE/CS/40337—14-Vol.2
	Illinois Inst. of Tech., Chicago (USA). Dept. of Mechanical Engineering	
	8:29848	DOE/CS/40337—14-Vol.5
	Fauske and Associates, Inc., Burr Ridge, IL (USA)	
	8:29849	DOE/CS/40337—14-Vol.6
FG02-80CS84006	Stanford Univ., CA	
	8:30043	Journal of Physical Chemistry 86 NO. 24. 4694-4700 (25 Nov 1982).
FG02-81ET46634	Wisconsin State Government, Madison (USA)	
	8:29124	DOE/ET/46634—1
FG02-81R510313	Goodwill Industries, Inc., St. Paul, MN (USA)	
	8:29828	DOE/R5/10313—1
FG02-81R510329	Snell Environmental Group, Inc., Lansing, MI (USA)	
	8:29309	DOE/R5/10329—2
FG03-81CS69160	New York Inst. of Tech., Old Westbury (USA). Center for Energy Policy and Research	
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CONF-811012-	(IEEE symposium on nuclear science, San Francisco, CA, USA, 21-23 Oct 1981)			
70	NTIS, PC A02/MF A01	DE83010783	MN -37	8:30276
71	NTIS, PC A02/MF A01; 1	DE83010699	MN -28	8:30277
CONF-8110168-	(NATO advanced study institute on diagnostic imaging in medicine, Castelvecchio, Italy, 11-23 Oct 1981)			
2	*See* CEA-CONF-6089	DE83700392	MN -37	8:30304
CONF-8110175-	(Symposium on research needs for evaluation of health effects of toxic chemical waste dumps, Research Triangle Park, NC, USA, 27-28 Oct 1981)			
2	*See* BNL-30740	DE83010849	MN -41	8:29750
CONF-8110235-	(Workshop on nuclear physics, Trieste, Italy, 4 Oct-2 Nov 1981)			
1	*See* CEA-CONF-6155	DE83700181	MN -34D	8:30663
CONF-8110264-	(ANL/International Centre for Heat and Mass Transfer course on LWRs, Belgrad, Yugoslavia, 11-15 Oct 1981)			
2	NTIS, PC A04/MF A01; 1	DE83009576	MN -78	8:29637
CONF-8110265-	(American Society of Civil Engineers fall meeting, St. Louis, MO, USA, 26-30 Oct 1981)			
1	NTIS, PC A02/MF A01; 1	DE83008947	MN -32	8:31014
CONF-8110266-	(International ANS/ENS topical meeting on probabilistic risk assessment, Port Chester, NY, USA, 20-24 Oct 1981)			
1	NTIS, PC A02/MF A01	DE83009673	MN -80	8:29638
CONF-8110268-	(Subseabed disposal program annual workshop, Denver, CO, USA, 27-29 Oct 1981)			
1	NTIS, PC A02/MF A01; 1	DE83010637	MN -4	8:29123
CONF-8110269-	(Workshop on physics and astrophysics with a multikiloton underground track-detector, Rome, Italy, 29-31 Oct 1981)			
1	*See* ANL-HEP-CP-82-03	DE83009600	MN -34D	8:30271
CONF-8110271-	(Symposium on northeastern accelerator personnel, Ontario, Canada, 14-16 Oct 1981)			
1	NTIS, PC A02/MF A01	DE83010601	MN -28	8:30223

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CONF-811122-	(Annual meeting of the Materials Research Society, Boston, MA, USA, 16-19 Nov 1981)			
Pt.2	*See* etariat, Materials Research Society, 102C Materials Research Lab., University Park, PA 16802		MN -90i	8:28837
CONF-811154-	(International conference on fast reactor fuel cycles, London, UK, 9-12 Nov 1981)			
4	*See* CEA-CONF-6156	DE83700388	MN -79	8:29578
CONF-811157-	(IAEA specialists' meeting on examination of fuel assembly for water cooled power reactors, Tokyo, Japan, 9-13 Nov 1981)			
3	*See* CEA-CONF-6081	DE83701530	MN -78	8:29615
CONF-8111124-	(Topical meeting LMFBR steam generators, Genoa, Italy, 30 Nov-2 Dec 1981)			
1	*See* CEA-CONF-6179	DE83700389	MN -79	8:29579
CONF-8111143-	(Autumn school on modern methods in high frequency spectroscopy, Reinhardsbrunn, German Democratic Republic, 2-6 Nov 1981)			
1	NTIS, PC A02/MF A01; 1	DE83007853	MN -4	8:30075
CONF-8111151-	(2. workshop on detectors for TRISTAN, Tsukuba, Japan, 16-11 Nov 1981)			
1	*See* ANL-HEP-CP-82-01	DE83009689	MN -37	8:30270
CONF-811212-	(4. international conference on alternative energy sources, Miami Beach, FL, USA, 14-16 Dec 1981)			
18	NTIS, PC A02/MF A01; 1	DE83009008	MN -11	8:30348
CONF-811258-	(Thermo regenerative electrochemical systems workshop, Alexandria, VA, USA, 3-4 Dec 1981)			
	See SERI/CP-234-1577	DE83002097	MN -61d	8:29790
CONF-811264-	(SFEN meeting on power station control to meet the electric network requirements, Paris, France, 8-9 Dec 1981)			
2	*See* CEA-CONF-6138	DE83700385	MN -79	8:29576
CONF-811266-	(Symposium on hydraulics and noise S.H.F., Paris, France, 15 Dec 1981)			
1	*See* CEA-CONF-6189	DE83700390	MN -79	8:29580
CONF-811278-	(Subseabed disposal program annual meeting, Denver, CO, USA, 27-30 Dec 1981)			
1	NTIS, PC A02/MF A01	DE83010631	MN -4	8:30074
CONF-820136-	(1. international conference on non-potential interactions and their Lie-admissible treatment, Orleans, France, 5-9 Jan 1982)			
	Hadronic J., 5: No. 5, 1764-1773(Aug 1982)			8:30698
	Hadronic J., 5: No. 5, 1781-1801(Aug 1982)			8:30699
	Hadronic J., 5: No. 5, 1893-1900(Aug 1982)			8:30700
	Hadronic J., 5: No. 5, 1923-1947(Aug 1982)			8:30701
	Hadronic J., 5: No. 4, 1194-1276(Jun 1982)			8:30702
	Hadronic J., 5: No. 4, 1277-1366(Jun 1982)			8:30703
	Hadronic J., 5: No. 4, 1367-1403(Jun 1982)			8:30704
	Hadronic J., 5: No. 5, 1754-1763(Aug 1982)			8:30723
	Hadronic J., 5: No. 5, 1812-1841(Aug 1982)			8:30724
	Hadronic J., 5: No. 4, 1517-1528(Jun 1982)			8:30725
	Hadronic J., 5: No. 4, 1529-1545(Jun 1982)			8:30726
	Hadronic J., 5: No. 5, 1627-1631(Aug 1982)			8:30820
	Hadronic J., 5: No. 5, 1717-1733(Aug 1982)			8:30821
	Hadronic J., 5: No. 5, 1738-1747(Aug 1982)			8:30822
	Hadronic J., 5: No. 5, 1774-1780(Aug 1982)			8:30823
	Hadronic J., 5: No. 5, 1842-1858(Aug 1982)			8:30824
	Hadronic J., 5: No. 5, 1901-1922(Aug 1982)			8:30825
	Hadronic J., 5: No. 5, 1632-1657(Aug 1982)			8:30829
	Hadronic J., 5: No. 5, 1658-1666(Aug 1982)			8:30830
	Hadronic J., 5: No. 5, 1667-1700(Aug 1982)			8:30831
	Hadronic J., 5: No. 5, 1701-1716(Aug 1982)			8:30832
	Hadronic J., 5: No. 5, 1734-1737(Aug 1982)			8:30833
	Hadronic J., 5: No. 5, 1748-1753(Aug 1982)			8:30834
	Hadronic J., 5: No. 5, 1802-1811(Aug 1982)			8:30835
	Hadronic J., 5: No. 5, 1859-1892(Aug 1982)			8:30836
	Hadronic J., 5: No. 4, 1404-1450(Jun 1982)			8:30837
	Hadronic J., 5: No. 4, 1451-1478(Jun 1982)			8:30838
	Hadronic J., 5: No. 4, 1479-1488(Jun 1982)			8:30839
	Hadronic J., 5: No. 4, 1489-1516(Jun 1982)			8:30840
	Hadronic J., 5: No. 4, 1546-1563(Jun 1982)			8:30841
	Hadronic J., 5: No. 4, 1564-1612(Jun 1982)			8:30842
	Hadronic J., 5: No. 4, 1613-1626(Jun 1982)			8:30843
CONF-820205-	(111. AIME annual meeting, Dallas, TX, USA, 14-18 Feb 1982)			
7	NTIS, PC A02/MF A01	DE83010632	MN -94c	8:29872
CONF-820273-	(2. Alaska coal marketing conference, Anchorage, AK, USA, 18-19 Feb 1982)			
	Resource Development Council for Alaska, 444 West 7th Ave., Box 516, Anchorage, AK, $30.00		MN -88	8:28971
CONF-820312-	(Solar storage workshop, Jeddah, Saudi Arabia, 21-24 Mar 1982)			
1	NTIS, PC A02/MF A01; 1	DE83009681	MN -94a	8:29706
CONF-820356-	(Conference of the National Institute of Environmental Health Sciences, Research Triangle Park, NC, USA, 28-31 Mar 1982)			
4	NTIS, PC A03/MF A01	DE83009836	MN -48	8:30530
5	NTIS, PC A03; 3	DE83009858	ND -48	8:30473

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CONF-820364-	(Symposium on unsaturated flow and transport modeling, Seattle, WA, USA, 23-24 Mar 1982)			
	See NUREG/CP-0030	DE83001612	MN -70B	8:30589
CONF-820389-	(7. international technical conference on slurry transportation, Lake Tahoe, NV, USA, 23-26 Mar 1982)			
	Washington, DC; Slurry Transport Association (1982).			8:28912
CONF-820407-	(27. ASME international gas turbine conference, London, UK, 18-20 Apr 1982)			
	Am. Soc. Mech. Eng., [Pap.], No. 82-GT-197, 1-8(1982)			8:28820
	Am. Soc. Mech. Eng., [Pap.], No. 82-GT-164, 1-8(1982)			8:29519
	Am. Soc. Mech. Eng., [Pap.], No. 82-GT-171, 1-8(1982)			8:29520
CONF-820419-	(Enhanced oil recovery symposium, Tulsa, OK, USA, 4-7 Apr 1982)			
	Soc. Pet. Eng. AIME, Pap., 111-130(1982)			8:28988
	Society of Petroleum Engineers of AIME, 6200 N. Central Expwy., Dallas, TX 75206		MN -92a	8:28998
	Soc. Pet. Eng. AIME, Pap., 17-34(1982)			8:28999
	Soc. Pet. Eng. AIME, Pap., 35-50(1982)			8:29000
	Soc. Pet. Eng. AIME, Pap., 51-75(1982)			8:29001
	Soc. Pet. Eng. AIME, Pap., 99-109(1982)			8:29002
	Soc. Pet. Eng. AIME, Pap., 131-138(1982)			8:29003
	Soc. Pet. Eng. AIME, Pap., 139-147(1982)			8:29004
	Soc. Pet. Eng. AIME, Pap., 149-162(1982)			8:29005
	Soc. Pet. Eng. AIME, Pap., 163-196(1982)			8:29006
	Soc. Pet. Eng. AIME, Pap., 197-215(1982)			8:29007
	Soc. Pet. Eng. AIME, Pap., 217-240(1982)			8:29008
	Soc. Pet. Eng. AIME, Pap., 241-263(1982)			8:29009
	Soc. Pet. Eng. AIME, Pap., 265-284(1982)			8:29010
	Soc. Pet. Eng. AIME, Pap., 285-307(1982)			8:29011
	Soc. Pet. Eng. AIME, Pap., 309-327(1982)			8:29012
	Soc. Pet. Eng. AIME, Pap., 329-339(1982)			8:29013
	Soc. Pet. Eng. AIME, Pap., 341-355(1982)			8:29014
	Soc. Pet. Eng. AIME, Pap., 357-365(1982)			8:29015
	Soc. Pet. Eng. AIME, Pap., 367-379(1982)			8:29016
	Soc. Pet. Eng. AIME, Pap., 381-389(1982)			8:29017
	Soc. Pet. Eng. AIME, Pap., 391-408(1982)			8:29018
	Soc. Pet. Eng. AIME, Pap., 409-415(1982)			8:29019
	Soc. Pet. Eng. AIME, Pap., 417-432(1982)			8:29020
	Soc. Pet. Eng. AIME, Pap., 433-440(1982)			8:29021
	Soc. Pet. Eng. AIME, Pap., 441-454(1982)			8:29022
	Soc. Pet. Eng. AIME, Pap., 481-486(1982)			8:29023
	Soc. Pet. Eng. AIME, Pap., 487-495(1982)			8:29024
	Soc. Pet. Eng. AIME, Pap., 497-521(1982)			8:29025
	Soc. Pet. Eng. AIME, Pap., 523-536(1982)			8:29026
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	Soc. Pet. Eng. AIME, Pap., 559-585(1982)			8:29028
	Soc. Pet. Eng. AIME, Pap., 587-609(1982)			8:29029
	Soc. Pet. Eng. AIME, Pap., 611-650(1982)			8:29030
	Soc. Pet. Eng. AIME, Pap., 651-667(1982)			8:29031
	Soc. Pet. Eng. AIME, Pap., 669-688(1982)			8:29032
	Soc. Pet. Eng. AIME, Pap., 689-715(1982)			8:29033
	Soc. Pet. Eng. AIME, Pap., 717-740(1982)			8:29034
	Soc. Pet. Eng. AIME, Pap., 741-762(1982)			8:29035
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	Soc. Pet. Eng. AIME, Pap., 783-802(1982)			8:29037
	Soc. Pet. Eng. AIME, Pap., 803-816(1982)			8:29038
	Soc. Pet. Eng. AIME, Pap., 817-837(1982)			8:29039
	Soc. Pet. Eng. AIME, Pap., 839-870(1982)			8:29040
	Soc. Pet. Eng. AIME, Pap., 871-889(1982)			8:29041
	Soc. Pet. Eng. AIME, Pap., 891-900(1982)			8:29042
	Soc. Pet. Eng. AIME, Pap., 901-909(1982)			8:29043
	Soc. Pet. Eng. AIME, Pap., 911-920(1982)			8:29044
	Soc. Pet. Eng. AIME, Pap., 921-931(1982)			8:29045
	Soc. Pet. Eng. AIME, Pap., 933-952(1982)			8:29046
	Soc. Pet. Eng. AIME, Pap., 953-962(1982)			8:29047
	Soc. Pet. Eng. AIME, Pap., 455-480(1982)			8:29071
	Soc. Pet. Eng. AIME, Pap., 9-15(1982)			8:29950
	Soc. Pet. Eng. AIME, Pap., 77-97(1982)			8:29951
CONF-820438-	(NEANDC/NEACRP specialists meeting on fast-neutron capture cross sections, Argonne, IL, USA, 20-23 Apr 1982)			
	See ANL-83-4	DE83008920	MN -79d	8:30746
CONF-820455-	(2. international RETRAN meeting, San Diego, CA, USA, 28 Apr 1982)			
	See EPRI-NP-2494-SR	DE82905838	MN -78	8:29642
CONF-820492-	(30. annual meeting of the Radiation Research Society, Salt Lake City, UT, USA, 18-22 Apr 1982)			
Pt.1	*See* PNL-SA-11049	DE83007285	STD -48	8:30496
CONF-8204108-	(1. international mine water congress, Budapest, Hungary, 19-24 Apr 1982)			
1	NTIS, PC A02/MF A01	DE83009586	MN -95d	8:29821
CONF-8204120-	(16. Southeastern seminar on thermal sciences, Miami, FL, USA, 19-21 Apr 1982)			
	Univ. of Miami, P.O. Box 248294, Coral Gables, FL 33124, 540.00			8:30133

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CONF-8204123-	(4. world recycling congress, New Orleans, LA, USA, 5-7 Apr 1982)			
1	NTIS, PC A02/MF A01; 1	DE83009562	MN -95e	8:29839
CONF-8204126-	(ASME/IEEE joint spring conference, Erie, PA, USA, 19-21 Apr 1982)			
1	NTIS, PC A03/MF A01	DE83010695	MN -96	8:29860
CONF-820508-	(Spring meeting of the Electrochemical Society, Montreal, Canada, 9-14 May 1982)			
10	NTIS, PC A02/MF A01	DE83010812	MN -94c	8:29710
CONF-820545-	(5. international conference on plasma surface, Gatlinburg, TN, USA, 3-5 May 1982)			
21	*See* EUR-CEA-FC-1145	DE83700216	MN -20	8:30898
CONF-820547-	(84. annual meeting of the American Ceramic Society, Cincinnati, OH, USA, 2-5 May 1982)			
17	NTIS, PC A02/MF A01	DE83009015	MN -25	8:29928
CONF-8205153-	(IEA/AFBC technical meeting, Petten, Netherlands, 1 May 1982)			
	See P-82/13			8:28868
CONF-820601-	(ASME pressure vessel and piping conference, Orlando, FL, USA, 27 Jun-1 Jul 1982)			
	Am. Soc. Mech. Eng., Pressure Vessels Piping Div., [Tech. Rep.] PVP, 63: 31-44(1982)			8:29556
	Am. Soc. Mech. Eng., Pressure Vessels Piping Div., [Tech. Rep.] PVP, 64: 127-136(1982)			8:29592
	Am. Soc. Mech. Eng., Pressure Vessels Piping Div., [Tech. Rep.] PVP, 63: 223(1982)			8:29612
	Am. Soc. Mech. Eng., Pressure Vessels Piping Div., [Tech. Rep.] PVP, 64: 91-105(1982)			8:29613
	Am. Soc. Mech. Eng., Pressure Vessels Piping Div., [Tech. Rep.] PVP, 64: 298-316(1982)			8:29699
	Am. Soc. Mech. Eng., Pressure Vessels Piping Div., [Tech. Rep.] PVP, 64: 381(1982)			8:29700
	Am. Soc. Mech. Eng., Pressure Vessels Piping Div., [Tech. Rep.] PVP, 64: 183-198(1982)			8:29701
	Am. Soc. Mech. Eng., Pressure Vessels Piping Div., [Tech. Rep.] PVP, 64: 1-18(1982)			8:30131
29	NTIS, PC A02/MF A01; 1	DE83010781	MN -79a	8:29627
CONF-820609-	(American Nuclear Society annual meeting, Los Angeles, CA, USA, 6-11 Jun 1982)			
	Trans. Am. Nucl. Soc., 41: 276-277(Jun 1982)			8:29167
	Trans. Am. Nucl. Soc., 41: 277-278(Jun 1982)			8:29168
	Trans. Am. Nucl. Soc., 41: 71(Jun 1982)			8:29169
	Trans. Am. Nucl. Soc., 41: 75(Jun 1982)			8:29170
	Trans. Am. Nucl. Soc., 41: 282-283(Jun 1982)			8:29171
	Trans. Am. Nucl. Soc., 41: 478-480(Jun 1982)			8:30298
	Trans. Am. Nucl. Soc., 41: 74(Jun 1982)			8:30346
	Trans. Am. Nucl. Soc., 41: 72(Jun 1982)			8:30347
	Trans. Am. Nucl. Soc., 41: 486-487(Jun 1982)			8:30798
	Trans. Am. Nucl. Soc., 41: 475-476(Jun 1982)			8:30799
	Trans. Am. Nucl. Soc., 41: 164(Jun 1982)			8:30950
	Trans. Am. Nucl. Soc., 41: 163(Jun 1982)			8:30951
	Trans. Am. Nucl. Soc., 41: 163(Jun 1982)			8:30952
	Trans. Am. Nucl. Soc., 41: 164(Jun 1982)			8:30953
CONF-820621-	(30. power sources symposium, Atlantic City, NJ, USA, 7-10 Jun 1982)			
6	NTIS, PC A02/MF A01	DE83010646	MN -94cb	8:29711
CONF-820636-	(5. international symposium on the scientific basis for radioactive waste management, Berlin, F.R. Germany, 7-10 Jun 1982)			
	Elsevier Science Publishing Co., Inc., 52 Vanderbilt Ave., New York, NY 10017			8:29220
CONF-820645-	(20. symposium on engineering aspects of magnetohydrodynamics, Los Angeles, CA, USA, 14-16 Jun 1982)			
9	NTIS, PC A02/MF A01	DE83010727	MN -90g	8:29779
CONF-8206116-	(DPF summer study on elementary particle physics and future facilities (APS), Aspen, CO, USA, 28 Jun-16 Jul 1982)			
27	*See* ANL-HEP-CP-82-34	DE83009518	MN -34D	8:30272
29	*See* ANL-HEP-CP-82-40	DE83009433	MN -34D	8:30173
CONF-8206117-	(13. international symposium on multiparticle dynamics, Volendam, Netherlands, 6-11 Jun 1982)			
7	*See* ANL-HEP-CP-82-29	DE83009519	MN -34D	8:30709
CONF-8206118-	(6. annual international collaboration of advanced neutron sources meeting, Argonne, IL, USA, 28 Jun-2 Jul 1982)			
	See ANL-82-80	DE83008718	MN -25	8:29268
CONF-8206178-	(6. CADE conference on automated deduction, New York, NY, USA, 1 Jun 1982)			
1	NTIS, PC A03/MF A01	DE83008686	MN -32	8:30989
2	NTIS, PC A03/MF A01	DE83010578	MN -32	8:30990
CONF-820704-	(International topical meeting on LMFBR safety, Lyon, France, 18-23 Jul 1982)			
47	NTIS, PC A02/MF A01; 1	DE83009027	MN -79p	8:29581
48	NTIS, PC A02/MF A01	DE83009491	MN -79p	8:29628
49	NTIS, PC A02/MF A01	DE83009691	MN -79p	8:29629
50	NTIS, PC A02/MF A01	DE83008929	MN -79p	8:29630
51	NTIS, PC A02/MF A01; 1	DE83009034	MN -79p	8:29631

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CONF-820723-	(National conference on environmental engineering, Minneapolis, MN, USA, 14-16 Jul 1982)			
3	NTIS, PC A02/MF A01	DE83009006	MN -95e	8:29838
CONF-820777-	(EPRI cogeneration seminar, Berkeley, CA, USA, 28-30 Jul 1982)			
	See EPRI-EA/EM-2893	DE83901876	MN -98F	8:29760
CONF-820810-	(10. international mathematics and computers simulation congress on systems simulation and scientific computation, Montreal, Canada, 9-13 Aug 1982)			
19	NTIS, PC A02/MF A01; 1	DE83009037	MN -79k	8:29632
20	NTIS, PC A02/MF A01; 1	DE83010759	MN -79p	8:29633
CONF-8208130-	(Workshop on techniques for the production and utilization of polarization radiation in the vacuum ultraviolet, London, UK, 18-20 Aug 1982)			
1	NTIS, PC A02/MF A01; 1	DE83010595	MN -34A	8:30635
CONF-820911-	(Symposium on low level waste disposal, Washington, DC, USA, 29-30 Sep 1982)			
	See NUREG/CP-0028-Vol.3	DE83009128	MN -70B	8:29135
CONF-820989-	(Workshop on science underground, Los Alamos, NM, USA, 27 Sep-1 Oct 1982)			
6	*See* FERMILAB-CONF-83/22	DE83008914	MN -34D	8:30607
CONF-820998-	(Workshop on the interface between radiation physics and radiation chemistry, Argonne, IL, USA, 9-10 Sep 1982)			
4	NTIS, PC A02/MF A01; 1	DE83009773	MN -4	8:30788
CONF-8209111-	(Energy Materials Coordinating Committee contractor's meeting on problems and opportunity structural ceramics, Germantown, MD, USA, 29-30 Sep 1982)			
	NTIS, PC A13/MF A01; 1	DE83010175	STD -25	8:29929
CONF-8209113-	(CECAM workshop, Paris, France, 13 Sep-1 Oct 1982)			
3	*See* LA-UR-83-586	DE83009939	MN -21	8:30907
CONF-8209124-	(Workshop on polarized targets and materials, Upton, NY, USA, 16 Sep 1982)			
1	*See* ANL-HEP-CP-82-37	DE83009079	MN -25	8:30002
2-Summ.	*See* ANL-HEP-CP-82-56	DE83009449	MN -28	8:30204
CONF-821011-	(IEEE nuclear science symposium, Washington, DC, USA, 20-22 Oct 1982)			
49	*See* ANL-HEP-CP-82-49	DE83009447	MN -28	8:30273
CONF-821012-	(Institute for Management Sciences/Operations Research Society of America joint meeting, San Diego, CA, USA, 25-27 Oct 1982)			
6	*See* BNL-32832	DE83010826	MN -95c	8:29820
CONF-821015-	(Electrochemical Society fall meeting, Detroit, MI, USA, 17-22 Oct 1982)			
11	NTIS, PC A02/MF A01; 1	DE83010734	MN -94cb	8:29712
CONF-821024-	(10. international symposium on discharges and electrical insulation in vacuum, Columbia, SC, USA, 25-28 Oct 1982)			
8	*See* GEPP-OP-659	DE83010323	MN -38	8:30142
CONF-821066-	(Symposium for Northeastern Accelerator personnel, Seattle, WA, USA, 6-8 Oct 1982)			
4	NTIS, PC A02/MF A01	DE83008911	MN -28	8:30633
CONF-821089-	(6. international workshop on laser interaction and related plasma phenomena, Monterey, CA, USA, 25-29 Oct 1982)			
9	*See* UCRL-88056	DE83010103	MN -21	8:30929
CONF-8210107-	(Workshop on Drell-Yan processes, Batavia, IL, USA, 7-8 Oct 1982)			
4	*See* ANL-HEP-CP-82-72	DE83008928	MN -34D	8:30678
CONF-8210113-	(American Physical Society meeting on pariticles and fields, College Park, MD, USA, 28-30 Oct 1982)			
2	*See* ANL-HEP-CP-82-68	DE83009517	MN -34D	8:30677
CONF-8210137-	(CECAM workshop on the flux-limiter and heat flow instabilities, Orsay, France, 1 Oct 1982)			
1	*See* LA-UR-83-952	DE83009904	MN -21	8:30913
CONF-8210139-	(7. symposium on statistics and the environment, Washington, DC, USA, 4-5 Oct 1982)			
1	*See* BNL-32760	DE83010149	MN -41	8:30472
CONF-821141-	(National Fuel Cell seminar, Newport Beach, CA, USA, 14-18 Nov 1982)			
3	NTIS, PC A02/MF A01	DE83009645	MN -93	8:29784
CONF-821170-	(Conference on laser induced damage in optical materials, Boulder, CO, USA, 15-18 Nov 1982)			
2	*See* LA-UR-83-601	DE83009940	MN -34	8:30102
CONF-821182-	(Gulf coast lignite conference, Houston, TX, USA, 3-5 Nov 1982)			
1	*See* DOE/FC-1007	DE83009844	MN -90e	8:29966
CONF-821183-	(International conference on cometary exploration, Budapest, Hungary, 15-19 Nov 1982)			
1	*See* LA-UR-83-977	DE83009912	MN -34B	8:30620
CONF-821203-	(International conference on lasers, New Orleans, LA, USA, 13-17 Dec 1982)			
4	*See* BNL-32678	DE83010160	MN -34	8:30252
CONF-821211-	(5. DOE battery and electrochemical contractors' conference, Crystal City, VA, USA, 7-9 Dec 1982)			
7	NTIS, PC A02/MF A01	DE83010567	MN -94cc	8:29713
8	NTIS, PC A02/MF A01	DE83010568	MN -94cb	8:29714
9	NTIS, PC A02/MF A01	DE83010641	MN -94cb	8:29715

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10	NTIS, PC A02/MF A01	DE83010642	MN -94	8:29716
CONF-821217-	(ASHRAE/DOE conference on thermal performance of building envelopes, Las Vegas, NV, USA, 5-9 Dec 1982)			
4	*See* LBL-14509	DE83009984	MN -95d	8:29806
CONF-821231-	(Workshop on nonlinear problems in applied combustion, Rocquencourt, France, 7-10 Dec 1982)			
1	*See* LA-UR-83-875	DE83009886	MN -32	8:30095
CONF-830134-	(Orbis scientiae conference, Miami, FL, USA, 17-22 Jan 1983)			
1	*See* LA-UR-83-751	DE83009969	MN -34B	8:30613
2	*See* ANL-HEP-CP-83-05	DE83009522	MN -34D	8:30679
3	*See* BNL-32793	DE83010423	MN -34D	8:30253
CONF-830135-	(7. North American workshop on cataclysmic variables and low-mass X-ray binaries, Boston, MA, USA, 12-15 Jan 1983)			
1	*See* LA-UR-83-892	DE83009888	MN -34B	8:30619
2	*See* LA-UR-83-643	DE83010161	MN -34B	8:30612
CONF-830136-	(Workshop on positron-electron pairs in astrophysics, Greenbelt, MD, USA, 6-8 Jan 1983)			
1	*See* LA-UR-83-812	DE83009997	MN -34B	8:30618
CONF-830137-	(15. symposium on advances in gene technology: molecular genetics of plants and animals, Miami, FL, USA, 17-21 Jan 1983)			
1	*See* LBL-15715	DE83009947	MN -48	8:30440
CONF-830138-	(Symposium on nuclear physics, Oaxtepec, Mexico, 4-7 Jan 1983)			
1	NTIS, PC A03/MF A01; 1	DE83009794	MN -34C	8:30736
CONF-830139-	(Workshop on problems in unification and supergravity, La-Jolla, CA, USA, 12-16 Jan 1983)			
1	*See* SLAC-PUB-3053	DE83008936	MN -34D	8:30718
CONF-830201-	(Society of Automotive Engineers congress, Detroit, MI, USA, 28 Feb-4 Mar 1983)			
3	NTIS, PC A02/MF A01; 1	DE83009504	MN -96	8:29861
CONF-830204-	(International beta dosimetry symposium, Washington, DC, USA, 15-18 Feb 1983)			
10	*See* PNL-SA-10888	DE83010166	MN -4	8:30294
CONF-830205-	(Waste management conference, Tucson, AZ, USA, 27 Feb-3 Mar 1983)			
25	NTIS, PC A02/MF A01	DE83009837	MN -2	8:29283
CONF-830210-	(5. topical conference on radio frequency plasma heating, Madison, WI, USA, 21-23 Feb 1983)			
9	*See* GA-A-16979	DE83010005	MN -20a	8:30899
10	*See* UCRL-88568	DE83009321	MN -20f	8:30867
11	*See* GA-A-17011	DE83009987	MN -20f	8:30900
12	*See* GA-A-17026	DE83010196	MN -20a	8:30901
13	*See* DOE/ET/51013-75	DE83010247	MN -20f	8:30894
14	*See* DOE/ET/51013-72	DE83010254	MN -20g	8:30852
15	*See* DOE/ET/51013-73	DE83010250	MN -20g	8:30853
16	*See* DOE/ET/51013-74	DE83010246	MN -20a	8:30893
17	*See* DOE/ET/51013-71	DE83010253	MN -20a	8:30892
CONF-830223-	(Wire chamber conference, Vienna, Austria, 15-18 Feb 1983)			
3	*See* LA-UR-83-796	DE83010086	MN -34C	8:30291
CONF-830224-	(DPF workshop on collider detectors: present capabilities and future possibilities, Berkeley, CA, USA, 28 Feb-4 Mar 1983)			
1	*See* BNL-32718	DE83010436	MN -37	8:30274
2	*See* BNL-32783	DE83010857	MN -34D	8:30666
CONF-830225-	(Nuclear fuel cycle information workshop, Oak Ridge, TN, USA, 15-17 Feb 1983)			
3	NTIS, PC A05/MF A01; 1	DE83901523	MN -80	8:29537
CONF-830226-	(10. WATTEC annual energy conference, Knoxville, TN, USA, 25 Feb 1983)			
1	NTIS, PC A02/MF A01	DE83009651	MN -90d	8:29773
2	NTIS, PC A02/MF A01	DE83009859	MN -95d	8:29803
CONF-830301-	(ASME-JSME thermal engineering joint conference, Honolulu, HI, USA, 20-24 Mar 1983)			
12	NTIS, PC A02/MF A01; 1	DE83009860	MN -78	8:29634
14	NTIS, PC A02/MF A01; 1	DE83010144	MN -77	8:29569
CONF-830303-	(185. American Chemical Society national meeting, Seattle, WA, USA, 20-25 Mar 1983)			
15	NTIS, PC A02/MF A01	DE83009772	MN -04	8:29948
CONF-830304-	(American Nuclear Society topical conference on computational methods, Salt Lake City, UT, USA, 28-31 Mar 1983)			
18	*See* EGG-M-02483	DE83010442	MN -78	8:29640
19	*See* EGG-M-29782	DE83010399	MN -78	8:29641
CONF-830307-	(6. American Meteorological Society symposium on turbulence and diffusion, Boston, MA, USA, 22-25 Mar 1983)			
10	*See* BNL-32370	DE83005807	MN -11	8:30323
CONF-830308-	(American Insititute of Chemical Engineers national meeting, Houston, TX, USA, 27-31 Mar 1983)			
9	NTIS, PC A02/MF A01; 1	DE83010145	MN -92a	8:30039
10	NTIS, PC A03/MF A01; 1	DE83010141	MN -90b	8:28827
CONF-830311-	(Particle accelerator conference, Santa Fe, NM, USA, 21-23 Mar 1983)			
15	*See* SLAC-PUB-3082	DE83009883	MN -28	8:30242
41	*See* FERMILAB/TM-1176	DE83009778	MN -28	8:30184

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42	*See* FERMILAB/TM-1175	DE83009779	MN -28	8:30183
43	*See* FERMILAB/TM-1173	DE83009777	MN -28	8:30182
44	*See* LA-UR-83-851	DE83010098	MN -28	8:30145
45	*See* LA-UR-83-744	DE83009968	MN -32	8:30231
46	*See* LA-UR-83-743	DE83009967	MN -28	8:30191
47	*See* LA-UR-83-734	DE83009966	MN -28	8:30230
48	*See* LA-UR-83-827	DE83010076	MN -34	8:30118
49	*See* LA-UR-83-828	DE83010000	MN -28	8:30237
50	*See* LA-UR-83-757	DE83009975	MN -28	8:30234
51	*See* LA-UR-83-756	DE83009974	MN -28	8:30144
52	*See* LA-UR-83-768	DE83009991	MN -28	8:30171
53	*See* LA-UR-83-755	DE83009973	MN -28	8:30169
54	*See* LA-UR-83-754	DE83009972	MN -28	8:30233
55	*See* LA-UR-83-753	DE83009971	MN -28	8:30232
56	*See* LA-UR-83-752	DE83009970	MN -28	8:30192
57	*See* LA-UR-83-850	DE83010097	MN -28	8:30194
58	*See* LA-UR-83-844	DE83010081	MN -28	8:30238
59	*See* LA-UR-83-849	DE83010096	MN -28	8:30193
60	*See* LA-UR-83-660	DE83009977	MN -28	8:30224
61	*See* LA-UR-83-811	DE83010089	MN -28	8:30236
62	*See* LA-UR-83-956	DE83009908	MN -28	8:30240
63	*See* LA-UR-83-955	DE83009907	MN -28	8:30239
64	*See* BNL-32713	DE83010147	MN -28	8:30207
65	NTIS, PC A02/MF A01; 1	DE83010142	MN -28	8:30222
66	*See* LA-UR-83-585	DE83009938	MN -28	8:30254
67	*See* LA-UR-83-767	DE83009990	MN -28	8:30170
68	*See* LA-UR-83-766	DE83009989	MN -28	8:30235
69	*See* LA-UR-83-702	DE83009979	MN -28	8:30225
70	*See* LA-UR-83-706	DE83009957	MN -28	8:30117
71	*See* LA-UR-83-705	DE83009956	MN -34D	8:30188
72	*See* LA-UR-83-704	DE83009951	MN -28	8:30187
73	*See* LA-UR-83-703	DE83009950	MN -28	8:30186
74	*See* LA-UR-83-721	DE83009964	MN -38	8:30255
75	*See* LA-UR-83-720	DE83009963	MN -28	8:30229
76	*See* LA-UR-83-608	DE83009941	MN -28	8:30143
77	*See* LA-UR-83-719	DE83009962	MN -28	8:30228
78	*See* LA-UR-83-718	DE83009961	MN -28	8:30227
79	*See* LA-UR-83-717	DE83009960	MN -28	8:30226
80	*See* LA-UR-83-716	DE83009959	MN -28	8:30909
81	*See* LA-UR-83-707	DE83009958	MN -28	8:30189
82	*See* LA-UR-83-733	DE83009965	MN -28	8:30190
83	*See* BNL-32737	DE83010438	MN -28	8:30208
84	*See* BNL-32736	DE83010439	MN -28	8:30176
85	*See* BNL-32806	DE83010441	MN -28	8:30217
86	*See* BNL-32829	DE83010445	MN -28	8:30218
87	*See* BNL-32856	DE83010444	MN -28	8:30219
88	*See* BNL-32874	DE83010443	MN -28	8:30220
89	*See* BNL-32764	DE83010428	MN -34D	8:30177
90	*See* BNL-32765	DE83010427	MN -32	8:30209
91	*See* BNL-32774	DE83010432	MN -28	8:30212
92	*See* BNL-32766	DE83010434	MN -34A	8:30210
93	*See* BNL-32711	DE83010457	MN -28	8:30206
94	*See* BNL-32652	DE83010454	MN -28	8:30205
95	*See* BNL-32785	DE83010425	MN -28	8:30178
96	*See* BNL-32787	DE83010424	MN -28	8:30216
97	*See* BNL-32781	DE83010437	MN -28	8:30214
98	*See* BNL-32767	DE83010433	MN -28	8:30211
99	*See* BNL-32728	DE83010435	MN -28	8:30175
100	*See* UCRL-88264	DE83010261	MN -28	8:30196
101	*See* BNL-32776	DE83010431	MN -28	8:30213
102	*See* BNL-32784	DE83010426	MN -28	8:30215
103	NTIS, PC A02/MF A01; 1	DE83010709	MN -28	8:30180
104	NTIS, PC A02/MF A01	DE83010580	MN -28	8:30181
105	*See* ANL-HEP-CP-83-15	DE83010756	MN -28	8:30174
CONF-830316-	(Distributed solar collector conference, Albuquerque, NM, USA, 15-17 Mar 1983)			
2	NTIS, PC A02/MF A01	DE83008182	MN -62a	8:29419
CONF-830317-	(TMS/AIME meeting, Atlanta, GA, USA, 6-10 Mar 1983)			
2	NTIS, PC A02/MF A01	DE83009770	MN -51	8:29104
CONF-830323-	(15. biomass thermochemical conversion contractors' meeting, Atlanta, GA, USA, 16-17 Mar 1983)			
2	*See* BNL-32746	DE83010852	MN -61a	8:29299
CONF-830324-	(15. symposium on the interface of computer science and statistics, Houston, TX, USA, 16-19 Mar 1983)			
4	*See* UCRL-88958	DE83009848	MN -32	8:31006
CONF-830336-	(American Society for Metals meeting, Cleveland, OH, USA, 16 Mar 1983)			
1	NTIS, PC A02/MF A01	DE83009783	MN -25	8:29953
CONF-830337-	(Swiss Society of Astrophysics and Astronomy conference, Saas Fee, Switzerland, 21-26 Mar 1983)			
6	*See* LA-UR-83-787	DE83010090	MN -34B	8:30615
7	*See* LA-UR-83-786	DE83010094	MN -34B	8:30614
8	*See* LA-UR-83-790	DE83010083	MN -34B	8:30617
9	*See* LA-UR-83-789	DE83010082	MN -34B	8:30616

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CONF-830338-	(APCA specialty meeting on measurement and monitering of non-criteria toxic contaminants, Chicago, IL, USA, 22-24 Mar 1983)			
2	NTIS, PC A02/MF A01	DE83009787	MN -41	8:30331
3	NTIS, PC A02/MF A01	DE83009839	MN -11	8:30332
CONF-830339-	(Theoretical symposium on intense medium energy sources of strangeness, Santa Cruz, CA, USA, 19-21 Mar 1983)			
1	*See* LA-UR-83-841	DE83010079	MN -34C	8:30696
CONF-830340-	(International conference on heavy-ion physics and nuclear physics, Catania, Italy, 21-26 Mar 1983)			
1	NTIS, PC A02/MF A01	DE83009799	MN -34C	8:30778
CONF-830341-	(Conference on interactions between climate and biosphere, Osnabruck, F.R. Germany, 21-23 Mar 1983)			
1	NTIS, PC A02/MF A01	DE83009830	MN -11	8:30531
CONF-830342-	(US/Japan 3-D MHD workshop, Nagoya, Japan, 8-11 Mar 1983)			
1	NTIS, PC A02/MF A01; 1	DE83009857	MN -20g	8:30848
CONF-830343-	(Coal development and utilization workshop on coal fired power plant cost estimating, Argonne, IL, USA, 18 Mar 1983)			
1	NTIS, PC A05/MF A01; 1	DE83009861	STD -90g	8:29492
CONF-830344-	(Automatic test generation workshop, San Francisco, CA, USA, 15-16 Mar 1983)			
1	*See* SAND-83-0732C	DE83010029	MN -32	8:31003
CONF-830345-	(American Physical Society meeting, Los Angeles, CA, USA, 21-25 Mar 1983)			
1	*See* SAND-82-2796C	DE83008906	MN -25	8:29958
CONF-830346-	(Computer animation method conference, Berlin, F.R. Germany, 14-17 Mar 1983)			
1	*See* EGG-M-30182	DE83010398	MN -80	8:29619
CONF-830347-	(Atomic industrial forum fuel cycle conference, Kansas City, MO, USA, 20-23 Mar 1983)			
1	*See* EGG-M-06183	DE83010397	MN -70B	8:29128
CONF-830406-	(5. topical meeting on technology of fusion energy, Knoxville, TN, USA, 26-28 Apr 1983)			
6	NTIS, PC A02/MF A01	DE83009589	MN -20	8:30888
10	NTIS, PC A02/MF A01	DE83009595	MN -20d	8:30889
11	*See* LA-UR-83-931	DE83009899	MN -20d	8:30912
13	*See* LA-UR-83-930	DE83009898	MN -20d	8:30911
14	*See* LA-UR-83-691	DE83009978	MN -20d	8:30908
16	*See* UCRL-88527	DE83009846	MN -20	8:30931
17	*See* UCRL-88977	DE83010257	MN -20d	8:30932
18	*See* LA-UR-83-968	DE83009910	MN -20d	8:30914
19	*See* LA-UR-83973	DE83009911	MN -20d	8:30915
20	*See* LA-UR-83-817	DE83009998	MN -20b	8:30910
21	*See* UCRL-88208	DE83010612	MN -21	8:30930
22	NTIS, PC A02/MF A01	DE83010770	MN -20c	8:30890
CONF-830423-	(5. symposium on safeguards and nuclear material management, Versailles, France, 19-21 Apr 1983)			
2	*See* MLM-3057(OP)	DE83010021	MN -25	8:29987
CONF-830425-	(Society of Photo-Optical Instrumentation Engineers conference, Santa Fe, NM, USA, 11-15 Apr 1983)			
2	*See* LA-UR-83-918	DE83009896	MN -37	8:30309
3	*See* LA-UR-83-953	DE83009905	MN -38	8:30105
4	*See* LA-UR-83-872	DE83009884	MN -34A	8:30644
5	*See* LA-UR-83-847	DE83010095	MN -34A	8:30643
6	*See* LA-UR-83-810	DE83010088	MN -37	8:30104
7	*See* LA-UR-83-804	DE83010087	MN -38	8:30103
8	*See* LA-UR-83-964	DE83009909	MN -4	8:30041
CONF-830426-	(ASTM symposium on chevron-notched specimens testing and stress analysis, Louisville, KY, USA, 21 Apr 1983)			
Abstr.	*See* SAND-83-0603	DE83010421	MN -66c	8:29350
CONF-830430-	(14. symposiumm on nondestructive evaluation, San Antonio, TX, USA, 19-21 Apr 1983)			
1	*See* UCRL-88942	DE83009810	MN -38	8:30135
CONF-830431-	(American Vacuum Society meeting, Albuquerque, NM, USA, 25-28 Apr 1983)			
1	*See* SAND-83-0825C	DE83009936	MN -25	8:29959
CONF-830432-	(Wind/solar energy conference, Kansas City, MO, USA, 25-26 Apr 1983)			
1	*See* SAND-82-2366C	DE83009935	MN -60	8:29486
2	*See* SAND-82-2341C	DE83009550	MN -60	8:29485
CONF-830433-	(SRC conference on intramolecular kinetics, Warwick, UK, 18-20 Apr 1983)			
1	*See* BNL-32706	DE83009727	MN -4	8:30631
CONF-830434-	(16. oil shale symposium, Golden, CO, USA, 13-15 Apr 1983)			
1	*See* SAND-82-2965C	DE83009931	MN -91	8:29066
CONF-830435-	(Annual meeting of the American Solar Energy Society, Minneapolis, MN, USA, 1-3 Apr 1983)			
1	*See* SERI/TP-231-1929	DE83010217	MN -61a	8:29327
CONF-830438-	(American Association for Aerosol Research annual meeting, College Park, MD, USA, 18-22 Apr 1983)			
1	NTIS, PC A02/MF A01	DE83009591	MN -11	8:30333

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CONF-830439-	(3. multi-phase flow and heat transfer symposium, Miami, FL, USA, 18-20 Apr 1983)			
1	NTIS, PC A03/MF A01; 1	DE83009590	MN -38	8:29635
2	NTIS, PC A02/MF A01	DE83010581	MN -80	8:29538
3	NTIS, PC A02/MF A01; 1	DE83010752	MN -79p	8:29636
CONF-830441-	(6. international conference of wind engineering, Auckland, New Zealand, 6-7 Apr 1983)			
1	*See* PNL-SA-10852	DE83010347	MN -60	8:29478
CONF-830443-	(Metallurgical coatings conference, San Diego, CA, USA, 18-22 Apr 1983)			
1	*See* SAND-83-0435C	DE83009003	MN -94cc	8:29887
CONF-830444-	(International school-seminar on heavy ion physics, Alushta, USSR, 14-21 Apr 1983)			
1	*See* UCRL-88414	DE83010366	MN -34C	8:30776
CONF-830445-	(Corrosion '83 conference, Anaheim, CA, USA, 18-22 Apr 1983)			
1	NTIS, PC A02/MF A01	DE83010746	MN -90h	8:28863
CONF-830446-	(American Power conference, Chicago, IL, USA, 18-20 Apr 1983)			
1	*See* GA-A-17053	DE83010809	MN -70	8:29129
CONF-830447-	(Workshop on small computers, Atlanta, GA, USA, 3-7 Apr 1983)			
1	NTIS, PC A02/MF A01; 1	DE83010713	MN -32	8:30986
CONF-830449-	(DOE contractors workshop, Oak Ridge, TN, USA, 21-23 Apr 1983)			
1	NTIS, PC A02/MF A01	DE83010798	MN -28	8:30634
CONF-830508-	(Electrochemical Society meeting, San Francisco, CA, USA, 8-13 May 1983)			
9	NTIS, PC A02/MF A01	DE83009592	MN -96	8:29717
12	NTIS, PC A02/MF A01; 1	DE83009609	MN -94c	8:29785
CONF-830520-	(2. international congress on building energy management, Ames, IA, USA, 31 May-3 Jun 1983)			
2	*See* LA-UR-83-885	DE83009887	MN -59c	8:29804
CONF-830533-	(Symposium on synthetic fuels from oil shale and tar sands, Louisville, KY, USA, 17-19 May 1983)			
1	*See* SAND-83-0828C	DE83009937	MN -91	8:29069
CONF-830534-	(5. international symposium on passivity, Bombannes, France, 30 May-3 Jun 1983)			
1	*See* BNL-32796	DE83010430	MN -25	8:29864
CONF-830536-	(Aesop operations managers' conference, Las Vegas, NV, USA, 4-6 May 1983)			
1	*See* UCRL-88736	DE83010613	MN -32	8:31017
CONF-830537-	(Custom integrated circuits conference, Rochester, NY, USA, 23-25 May 1983)			
1	*See* SAND-83-0823C	DE83010825	MN -38	8:30301
CONF-830538-	(6. international conference on radiation shielding, Tokyo, Japan, 16-20 May 1983)			
1	NTIS, PC A02/MF A01; 1	DE83010799	MN -79d	8:29582
CONF-830624-	(8. international symposium on military applications of blast simulation, Spiez, Switzerland, 20-24 Jun 1983)			
1	*See* SAND-83-0770C	DE83008904	MN -35	8:30318
COO-				
2101-47	*See* DOE/EV/02101-47	DE83009701	MN -48	8:30401
2176-47	*See* DOE/ER/02176-47	DE83010113	MN -34C	8:30775
2383-0086	*See* UIUCDCS-R-82-1103	DE83010114	MN -32	8:31007
2383-0087	*See* DOE/ER/02383-0087	DE83009574	MN -32	8:30992
2383-0091	*See* UIUCDCS-R-82-1116	DE83010995	MN -32	8:31008
2982-83	*See* DOE/CS/40202-T6	DE83007978	STD -95e	8:29301
CRWR-				
30	Univ. of Texas at Austin, Center for Research in Water Resources, 10100 Burnet Road, Austin, TX 78758		MN -11	8:28864
64	Univ. of Texas at Austin, Center for Research in Water Resources, 10100 Burnet Road, Austin, TX 78758		MN -11	8:30379
80	Univ. of Texas at Austin, Center for Research in Water Resources, 10100 Burnet Road, Austin, TX 78758		MN -11	8:30392
121	Univ. of Texas at Austin, Center for Research in Water Resources, 10100 Burnet Road, Austin, TX 78758		MN -11	8:30380
129-Vol.2	Univ. of Texas at Austin, Center for Research in Water Resources, 10100 Burnet Road, Austin, TX 78758		MN -11	8:30381
147-Vol.1	Univ. of Texas at Austin, Center for Research in Water Resources, 10100 Burnet Road, Austin, TX 78758		MN -11	8:30382
149	Univ. of Texas, Center for Research in Water Resources, 10100 Burnett Road, Austin, TX 78758		MN -11	8:30393
150	Univ. of Texas, Center for Research in Water Resources, 10100 Burnett Road, Austin, TX 78758		MN -11	8:30394
153	Univ. of Texas, Center for Research in Water Resources, 10100 Burnett Road, Austin, TX 78758		MN -11	8:30383
CTA-EAV-NT-				
019/ 80	NTIS (US Sales Only), PC A02/MF A01	DE83701514	MN -80	8:29611
CW-WR-				
76-020.109	NTIS, PC A03/MF A01	DE83008413	STD -90e	8:29493
76-020.110	NTIS, PC A03/MF A01; 1	DE83008412	STD -90e	8:29494
76-020.115	NTIS, PC A02/MF A01; 1	DE83008933	MN -90e	8:29495
81-024.6	*See* DOE/MC/16219-1403	DE83010140	STD -90c	8:28865

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DOE/AL/13121-T1	NTIS, PC A04/MF A01; 1	DE83010889	MN -62	8:29420
DOE/AL/22028-T2	NTIS, PC A05/MF A01; 1	DE83011200	MN -23	8:29284
DOE/BETC-82/4	NTIS, PC A06/MF A01	DE83010273	STD -92a	8:28990
DOE/BP-158	NTIS, PC A08/MF A01; 1	DE83010535	MN -95f	8:29822
158-Ex.Summ.	NTIS, PC A02/MF A01; 1	DE83010536	MN -95f	8:29823
159	NTIS, PC A13/MF A01; 1	DE83010538	MN -95f	8:29824
159-Exec.Summ.	NTIS, PC A03/MF A01; 1	DE83010537	MN -95f	8:29825
160-Exec.Summ.	NTIS, PC A02/MF A01; 1	DE83010350	MN -95f	8:29826
DOE/CE-0009/7	NTIS, PC A09/MF A01	DE83011213	STD -66	8:29432
DOE/CH/00016-1367	NTIS, PC A03/MF A01	DE83009577	STD -90e	8:28791
DOE/CH/10122-13	NTIS, PC A04/MF A01; 1	DE83010221	MN -59	8:29411
DOE/CH/10124-T1	NTIS, PC A03/MF A01	DE83010996	MN -93	8:29786
DOE/CONF-810622-Exc.Vol.1	*See* CONF-810622-Vol.1	DE83002533	ND -64	8:29355
DOE/CS/20038-2	NTIS, PC A03/MF A01; 1	DE83009448	MN -61a	8:29840
DOE/CS/20070-T1-Exec.Summ.	NTIS, PC A02/MF A01	DE83009305	MN -95d	8:29841
T1-Vol.1	NTIS, PC A09/MF A01; 1	DE83009306	MN -95d	8:29842
T1-Vol.2-App.	NTIS, PC A07/MF A01; 1	DE83009307	MN -95d	8:29843
DOE/CS/24360-1	NTIS, PC A02/MF A01	DE83010633	MN -95d	8:29844
T1	NTIS, PC A07/MF A01	DE83009528	MN -95d	8:29845
T2	NTIS, PC A04/MF A01	DE83010302	MN -95d	8:29846
DOE/CS/34090-T1	NTIS, PC A05/MF A01; 1	DE83009529	MN -59a	8:29412
DOE/CS/40064-3	NTIS, PC A15/MF A01; 1	DE83009342	MN -95f	8:29827
DOE/CS/40202-T6	NTIS, PC A06/MF A01; 1	DE83007978	STD -95e	8:29301
DOE/CS/40337-14-Vol.2	NTIS, PC A05/MF A01; 1	DE83009705	MN -95f	8:29847
14-Vol.5	NTIS, PC A04/MF A01; 1	DE83010330	MN -95f	8:29848
14-Vol.6	NTIS, PC A05/MF A01	DE83010332	MN -95f	8:29849
DOE/CS/50110-1	NTIS, PC A07/MF A01; 1	DE83009539	MN -96	8:29862
DOE/CS/69160-T4	NTIS, PC A03/MF A01; 1	DE83009346	MN -98	8:29768
DOE/DP-0001/11	NTIS, PC A02/MF A01	DE83010264	STD -16	8:29259
DOE/DP/40168-1	NTIS, PC A03/MF A01	DE83011125	MN -21	8:30891
DOE/EI/10601-T1	NTIS, PC A05/MF A01	DE83009914	MN -98	8:29734
T2	NTIS, PC A03/MF A01	DE83010109	MN -32	8:29735
T3	NTIS, PC A06/MF A01; 1	DE83010108	MN -35	8:29736
DOE/EI/10682-T1	NTIS, PC A03/MF A01	DE83010110	MN -32	8:30991
DOE/EI/70052-T2	NTIS, PC A05/MF A01; 1	DE83009928	MN -98	8:29737
T5	NTIS, PC A04/MF A01; 1	DE83009895	MN -32	8:29753
T8	NTIS, PC A02/MF A01; 1	DE83009894	MN -98	8:29738
T9	NTIS, PC A06/MF A01; 1	DE83009916	MN -98F	8:29739
T10	NTIS, PC A11/MF A01; 1	DE83009923	MN -98	8:29740
T11	NTIS, PC A07/MF A01; 1	DE83009922	MN -98	8:29741
T12	NTIS, PC A06/MF A01; 1	DE83009924	MN -98	8:29742
DOE/EIA-0032(82/13)	NTIS, PC A02/MF A01	DE83009769	MN -98B	8:29050
0075(82/12)	NTIS, PC A04/MF A01; 1	DE83010374	MN -98E	8:29496
0121(82/4Q)	NTIS, PC A05/MF A01	DE83010913	MN -98A	8:28978
0130(83/03)	NTIS, PC A05/MF A01; 1	DE83010282	MN -98	8:29774
0171(80)	NTIS, PC A07/MF A01; 1	DE83010828	MN -98	8:29297
0173(82)	NTIS, PC A05/MF A01	DE83009853	MN -98	8:29769
0204(83/01)	NTIS, PC A02/MF A01	DE83009948	MN -98	8:29726
0381	NTIS, PC A05/MF A01; 1	DE83010200	MN -98B	8:28986
0387	NTIS, PC A10/MF A01; 1	DE83010207	MN -98	8:29119
DOE/EP/12086-T1	NTIS, PC A03/MF A01; 1	DE83006539	MN -11	8:30349
DOE/ER/01736-T3	NTIS, PC A11/MF A01; 1	DE83009316	MN -93	8:29795
DOE/ER/02176-47	NTIS, PC A03/MF A01; 1	DE83010113	MN -34C	8:30775
DOE/ER/02383-0087	NTIS, PC A03/MF A01	DE83009574	MN -32	8:30992
DOE/ER/03077-180	NTIS, PC A06/MF A01; 1	DE83009537	MN -32	8:30099

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DOE/ER/04047-T1	NTIS, PC A02/MF A01; 1	DE83010305	MN -4	8:30040
DOE/ER/10119-T4	NTIS, PC A02/MF A01; 1	DE83010244	MN -11	8:30600
DOE/ER/10163-T1	NTIS, PC A09/MF A01; 1	DE83006947	STD -96	8:29857
DOE/ER/10418-T3	NTIS, PC A02/MF A01; 1	DE83010127	MN -34C	8:30759
DOE/ER/10450-3	NTIS, PC A11/MF A01; 1	DE83010647	MN -25	8:29873
DOE/ER/10501-7	NTIS, PC A02/MF A01; 1	DE83010111	MN -25	8:29874
DOE/ER/10569-T2	NTIS, PC A02/MF A01	DE83010918	MN -28	8:30168
DOE/ER/10603-3	NTIS, PC A08/MF A01; 1	DE83011021	STD -20g	8:30849
DOE/ER/10673-T1	NTIS, PC A02/MF A01; 1	DE83010619	MN -4	8:28792
T2	NTIS, PC A02/MF A01; 1	DE83010038	MN -4	8:28793
DOE/ER/10720-6	NTIS, PC A04/MF A01	DE83010339	MN -90d	8:29287
DOE/ER/10748-3	NTIS, PC A03/MF A01	DE83010372	MN -34A	8:30636
DOE/ER/10774-3	NTIS, PC A02/MF A01	DE83009438	MN -34B	8:30606
DOE/ER/10888-T1	NTIS, PC A02/MF A01; 1	DE83010115	MN -48	8:30434
DOE/ER/10971-1	NTIS, PC A02/MF A01	DE83009080	MN -4	8:29285
DOE/ER/12052-1	NTIS, PC A02/MF A01; 1	DE83010137	MN -25	8:29930
DOE/ER/12058-1	NTIS, PC A02/MF A01; 1	DE83010916	MN -4	8:29288
DOE/ER/12079-1PR	NTIS, PC A06/MF A01	DE83005316	MN -79k	8:29585
DOE/ER/12081-1	NTIS, PC A02/MF A01	DE83010917	MN -34	8:30637
DOE/ER/12093-T1	NTIS, PC A02/MF A01	DE83010801	MN -25	8:29875
T2	NTIS, PC A02/MF A01	DE83010804	MN -25	8:29876
DOE/ER/14945-1	NTIS, PC A02/MF A01	DE83010034	MN -4	8:30062
DOE/ER/40033-36	NTIS, PC A02/MF A01; 1	DE83008891	MN -34D	8:30668
DOE/ER/40085-1	NTIS, PC A02/MF A01	DE83008893	MN -34D	8:30669
DOE/ER/53140-7	NTIS, PC A03/MF A01	DE83009573	MN -20g	8:30850
DOE/ER/60038-T1	NTIS, PC A02/MF A01; 1	DE83010042	MN -48	8:30474
DOE/ER/70037-T1	NTIS, PC A02/MF A01	DE83005819	MN -94cc	8:29877
DOE/ER/72018-T1	NTIS, PC A03/MF A01; 1	DE83009929	MN -98	8:29762
T4	NTIS, PC A02/MF A01	DE83009889	MN -32	8:29743
T5	NTIS, PC A02/MF A01; 1	DE83009891	MN -32	8:29744
T6	NTIS, PC A02/MF A01	DE83009890	MN -32	8:29745
T7	NTIS, PC A03/MF A01; 1	DE83009925	MN -98	8:29746
DOE/ET/00038-2454	NTIS, PC A04/MF A01	DE83010648	MN -2	8:30076
DOE/ET/10324-T16	NTIS, PC A04/MF A01; 1	DE83011006	MN -90c	8:28794
T45	NTIS, PC A03/MF A01; 1	DE83011005	MN -90c	8:28795
T48	NTIS, PC A03/MF A01; 1	DE83011008	MN -90c	8:28796
DOE/ET/12138-1272	NTIS, PC A08/MF A01	DE83008487	STD -92a	8:29058
1275	NTIS, PC A07/MF A01	DE83009587	STD -92a	8:30587
1343	NTIS, PC A03/MF A01	DE83007805	STD -92a	8:29059
DOE/ET/13146-T1	NTIS, PC A02/MF A01	DE83007529	MN -90e	8:30153
T2	NTIS, PC A02/MF A01	DE83007528	MN -90e	8:30154
T3	NTIS, PC A02/MF A01; 1	DE83007527	MN -90e	8:30155
T4	NTIS, PC A02/MF A01	DE83007526	MN -90e	8:30156
T5	NTIS, PC A02/MF A01	DE83007525	MN -90e	8:30157
T6	NTIS, PC A02/MF A01	DE83007524	MN -90e	8:30158
T7	NTIS, PC A02/MF A01	DE83007333	MN -90e	8:30159
T8	NTIS, PC A02/MF A01; 1	DE83007466	MN -90e	8:30160
T9	NTIS, PC A02/MF A01	DE83007467	MN -90e	8:30161
T10	NTIS, PC A02/MF A01	DE83007468	MN -90e	8:30162
T11	NTIS, PC A02/MF A01	DE83007531	MN -90e	8:30163
T12	NTIS, PC A02/MF A01	DE83007530	MN -90e	8:30164
DOE/ET/14705-1394-Vol.1	NTIS, PC A07/MF A01	DE83008410	STD -90c	8:28797
1394-Vol.2	NTIS, PC A15/MF A01; 1	DE83008370	STD -90c	8:28798

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DOE/ET/14842-T20	NTIS, PC A02/MF A01	DE83010204	MN -90b	8:28799
DOE/ET/20000-T5	NTIS, PC A13/MF A01; 1	DE83007591	MN -61a	8:29302
DOE/ET/20254-T1	NTIS, PC A04/MF A01	DE83009684	MN -63e	8:29303
DOE/ET/27111-9	NTIS, PC A06/MF A01; 1	DE83011037	MN -66a	8:29433
DOE/ET/28365-T3	NTIS, PC A02/MF A01	DE83010373	MN -66	8:29424
DOE/ET/29069-T1	NTIS, PC A06/MF A01	DE83010017	MN -97a	8:29528
DOE/ET/34013-6	NTIS (US Sales Only), PC A05/MF A01	DE83010933	STD -78	8:29599
DOE/ET/34031-6	NTIS (US Sales Only), MF A01; 2	DE83010895	STD -78	8:29539
DOE/ET/34212-37	NTIS (US Sales Only), PC A04/MF A01	DE83010395	STD -78	8:29557
DOE/ET/34215-32	NTIS (US Sales Only), PC A03/MF A01	DE83010178	MN -78	8:29540
DOE/ET/37230-T1	NTIS, PC A02/MF A01	DE83009038	MN -80	8:29586
DOE/ET/46634-1	NTIS, PC A08/MF A01; 1	DE83008373	MN -70	8:29124
DOE/ET/51013-65	NTIS, PC A09/MF A01	DE83011020	STD -20a	8:30851
71	NTIS, PC A02/MF A01; 1	DE83010253	MN -20a	8:30892
72	NTIS, PC A02/MF A01; 1	DE83010254	MN -20g	8:30852
73	NTIS, PC A02/MF A01; 1	DE83010250	MN -20g	8:30853
74	NTIS, PC A02/MF A01; 1	DE83010246	MN -20a	8:30893
75	NTIS, PC A02/MF A01	DE83010247	MN -20f	8:30894
DOE/ET/53088-83	NTIS, PC A02/MF A01	DE83010321	MN -20g	8:30854
87	NTIS, PC A02/MF A01	DE83010322	MN -20f	8:30855
DOE/EV/02101-47	NTIS, PC A03/MF A01	DE83009701	MN -48	8:30401
DOE/EV/10413-1	NTIS, PC A02/MF A01	DE83009530	MN -48	8:30447
DOE/EV/10598-1	NTIS, PC A02/MF A01	DE83009531	MN -48	8:30532
DOE/FC-1007	NTIS, PC A02/MF A01; 1	DE83009844	MN -90e	8:28966
DOE/FE/00016-T6	NTIS, PC A09/MF A01; 1	DE83010356	MN -88	8:28887
DOE/FE/05120-T6	NTIS, PC A05/MF A01; 1	DE83010248	MN -90c	8:28800
DOE/ID/12015-T1	NTIS, PC A02/MF A01	DE83010806	MN -66	8:29429
DOE/ID/12079-80	NTIS, PC A04/MF A01; 1	DE83008657	MN -66b	8:29434
DOE/IG-0008/3	USDOE-TIC, PO Bx 62, Oak Ridge, TN 37830		STD -13	8:29770
0147	TIC	DE83007996	ND -98B	8:29727
0148	TIC	DE83007998	ND -11	8:29728
0149	TIC	DE83007999	ND -13	8:29729
0165	TIC	DE83007277	ND -13	8:29730
0166	USDOE-TIC, PO Bx 62, Oak Ridge, TN 37830; 1		ND -13	8:29260
0170	USDOE-TIC, PO Bx 62, Oak Ridge, TN 37830		ND -13	8:29731
0191	TIC	DE83009214	STD -70A	8:29261
0193	USDOE-TIC, PO Bx 62, Oak Ridge, TN 37830		ND -20b	8:30895
DOE/JPL/955506-83-3	NTIS, PC A03/MF A01; 1	DE83010194	STD -63b	8:29304
DOE/JPL/955676-4	NTIS, PC A07/MF A01; 1	DE83009983	STD -63b	8:29305
DOE/JPL/955843-83/9	NTIS, PC A03/MF A01; 1	DE83011050	STD -63b	8:29306
DOE/JPL/955902-82/6	NTIS, PC A02/MF A01	DE83009855	STD -63b	8:29307
DOE/JPL/956205-83/3	NTIS, PC A02/MF A01	DE83011221	STD -63b	8:29308
DOE/LC/10787-109	NTIS, PC A08/MF A01; 1	DE83010197	STD -91	8:29067
DOE/LC/RI-83-5	NTIS, PC A02/MF A01; 1	DE83009333	STD -91	8:29072
DOE/MC/08216-1276	NTIS, PC A12/MF A01; 1	DE83007234	STD -92a	8:29060
1380	NTIS, PC A04/MF A01; 1	DE83008462	MN -92a	8:29061
DOE/MC/14386-1377	NTIS, PC A09/MF A01; 1	DE83009661	STD -90c	8:28801
DOE/MC/14394-1365	NTIS, PC A10/MF A01; 1	DE83008964	STD -92a	8:29062
DOE/MC/14399-T5	NTIS, PC A03/MF A01	DE83010265	MN -90c	8:28802
DOE/MC/14875-1373	NTIS, PC A10/MF A01; 1	DE83008411	STD -90c	8:29049

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DOE/MC/16000-1294-Vol.1	NTIS, PC A06/MF A01; 1	DE83001905	STD -90e	8:28967
DOE/MC/16219-1403	NTIS, PC A04/MF A01; 1	DE83010140	STD -90c	8:28865
DOE/MC/19146-1400	NTIS, PC A05/MF A01; 1	DE83008761	STD -92a	8:29063
DOE/METC-83-53	NTIS, PC A02/MF A01	DE83007233	STD -90e	8:28909
83-57	NTIS, PC A22/MF A01; 1	DE83008940	STD -90e	8:29497
83-61	NTIS, PC A12/MF A01; 1	DE83010337	STD -90i	8:28866
DOE/METC/SP-193	NTIS, PC A04/MF A01; 1	DE83010521	STD -90h	8:28803
DOE/METC/TPR-83-4	NTIS, PC A03/MF A01; 1	DE83008455	STD -91	8:28991
DOE/NASA/0136-1	NTIS, PC A13/MF A01; 1	DE83010894	STD -90g	8:29780
DOE/NASA/0182-1	NTIS, PC A05/MF A01; 1	DE83009045	STD -60	8:29480
DOE/NASA/3303-4	NTIS, PC A02/MF A01	DE83011212	STD -60	8:29481
DOE/NBM-3008900	NTIS, PC A02/MF A01	DE83008900	MN -78	8:29639
3010529	NTIS, PC A07/MF A01; 1	DE83010529	MN -98	8:29763
3010569	NTIS, PC A03/MF A01; 1	DE83010569	MN -38	8:30100
3010753	NTIS, PC A02/MF A01	DE83010753	MN -34A	8:30638
DOE/NDC-29	NTIS, PC A04/MF A01	DE83010189	MN -22	8:29265
DOE/NE-0030/ 7	NTIS, PC A03/MF A01	DE83010266	MN -80	8:29395
DOE/PC/30098-T4	NTIS, PC A14/MF A01	DE82022259	STD -90i	8:28981
DOE/PC/30123-T7	NTIS, PC A11; 3	DE83010281	ND -88	8:28888
DOE/PC/30223-7	NTIS, PC A02/MF A01	DE83008762	MN -90a	8:28828
DOE/PC/30232-T6	NTIS, PC A03/MF A01	DE83008895	MN -90i	8:28804
DOE/PC/30249-T5	NTIS, PC A04/MF A01	DE83008160	STD -90a	8:28829
DOE/PC/30306-T10	NTIS, PC A04/MF A01	DE83010627	MN -90e	8:28968
DOE/PC/41263-T2	NTIS, PC A02/MF A01	DE83010891	MN -90d	8:28805
T3	NTIS, PC A04/MF A01; 1	DE83010892	MN -90d	8:28806
T4	NTIS, PC A02/MF A01	DE83010893	MN -90d	8:28807
DOE/PC/50783-T1	NTIS, PC A02/MF A01	DE83010222	MN -90d	8:28808
DOE/PC/50789-T1	NTIS, PC A02/MF A01	DE83009746	MN -90a	8:28832
DOE/PE/70045-1	NTIS, PC A04/MF A01; 1	DE83010685	MN -96	8:29816
DOE/PETC/TR-83/ 3	NTIS, PC A03/MF A01; 1	DE83009748	STD -90b	8:28910
83/ 4	NTIS, PC A03/MF A01; 2	DE83009749	STD -90b	8:28834
DOE/PR/10108-2	NTIS, PC A12/MF A01	DE83008129	MN -13	8:29732
DOE/R5/10313-1	NTIS, PC A02/MF A01	DE83009031	MN -95e	8:29828
DOE/R5/10329-2	NTIS, PC A04/MF A01; 1	DE83010988	MN -95e	8:29309
DOE/RA/29353-1	NTIS, PC A08/MF A01	DE83009313	STD -97c	8:29498
DOE/RA/50272-T1	NTIS, PC A04/MF A01; 1	DE83010022	MN -66a	8:29435
DOE/RA/50302-1	NTIS, PC A07/MF A01; 1	DE83010179	STD -95e	8:29850
DOE/RA/50339-1387-Vol.1	NTIS, PC A20/MF A01; 1	DE83010919	MN -90c	8:28809
1387-Vol.2	NTIS, PC A15/MF A01; 1	DE83009793	MN -90c	8:28810
DOE/RA/50366-1	NTIS, PC A10/MF A01; 1	DE83010622	STD -95e	8:29851
DOE/RA/50367-1	NTIS, PC A12/MF A01; 1	DE83010623	STD -95e	8:29852
DOE/RG-0057/ 2	NTIS, PC A03/MF A01	DE83010617	MN -90	8:29771
DOE/SF/11503-1	NTIS, PC A15/MF A01; 1	DE83010306	STD -66d	8:29464
DOE/SR/01072-4	NTIS, PC A07/MF A01; 1	DE83010304	MN -13	8:30399
5	NTIS, PC A08/MF A01; 1	DE83010303	MN -13	8:30369
6	NTIS, PC A02/MF A01; 1	DE83009450	MN -13	8:30370
8	NTIS, PC A12/MF A01; 1	DE83009014	MN -11	8:30588
9	NTIS, PC A03/MF A01	DE83008916	MN -11	8:30371
DOE/TIC-3387-S1	NTIS, PC A07/MF A01	DE83007212	STD -70	8:29125

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4500(Rev.71)	NTIS, PC A03/MF A01	DE83005965	STD -2	8:31015
DP-				
82-157-3	NTIS, PC A02/MF A01	DE83010987	STD -70	8:29126
1636	NTIS, PC A03/MF A01	DE83010815	STD -70	8:29127
1644	NTIS, PC A04/MF A01	DE83010342	STD -11	8:30363
EANDC(US)-				
215/ A	*See* DOE/NDC-29	DE83010189	MN -22	8:29265
ECE/COAL-				
67	United Nations, New York, NY			8:28889
68	United Nations, New York, NY			8:29853
69	United Nations, New York, NY			8:28890
70	United Nations, New York, NY			8:28891
71	United Nations, New York, NY			8:28892
72	United Nations, New York, NY			8:28979
73	United Nations, New York, NY			8:28893
EGG-				
2250	NTIS, PC A03/MF A01	DE83010979	STD -78	8:29558
10282-5001	NTIS, PC A02/MF A01	DE83010524	MN -38	8:30305
EGG-M-				
02483	NTIS, PC A02/MF A01	DE83010442	MN -78	8:29640
06183	NTIS, PC A02/MF A01	DE83010397	MN -70B	8:29128
29782	NTIS, PC A02/MF A01; 1	DE83010399	MN -78	8:29641
30182	NTIS, PC A02/MF A01	DE83010398	MN -80	8:29619
EHE-				
77-01-Vol.1	*See* CRWR-147-Vol.1		MN -11	8:30382
EPRI-AP-				
2906	NTIS, PC A06/MF A01	DE83011036	MN -60	8:29482
2929	NTIS, PC A06/MF A01	DE83901926	MN -25	8:29878
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83-703	NTIS, PC A02/MF A01; 1	DE83009950	MN -28	8:30186
83-704	NTIS, PC A02/MF A01	DE83009951	MN -28	8:30187
83-705	NTIS, PC A02/MF A01	DE83009956	MN -34D	8:30188
83-706	NTIS, PC A02/MF A01	DE83009957	MN -28	8:30117
83-707	NTIS, PC A02/MF A01	DE83009958	MN -28	8:30189
83-716	NTIS, PC A02/MF A01	DE83009959	MN -28	8:30909
83-717	NTIS, PC A02/MF A01; 1	DE83009960	MN -28	8:30226
83-718	NTIS, PC A02/MF A01	DE83009961	MN -28	8:30227
83-719	NTIS, PC A02/MF A01	DE83009962	MN -28	8:30228
83-720	NTIS, PC A02/MF A01	DE83009963	MN -28	8:30229
83-721	NTIS, PC A02/MF A01	DE83009964	MN -38	8:30255
83-733	NTIS, PC A02/MF A01	DE83009965	MN -28	8:30190
83-734	NTIS, PC A02/MF A01; 1	DE83009966	MN -28	8:30230
83-743	NTIS, PC A02/MF A01; 1	DE83009967	MN -28	8:30191
83-744	NTIS, PC A02/MF A01	DE83009968	MN -32	8:30231
83-751	NTIS, PC A02/MF A01	DE83009969	MN -34B	8:30613
83-752	NTIS, PC A02/MF A01; 1	DE83009970	MN -28	8:30192
83-753	NTIS, PC A02/MF A01; 1	DE83009971	MN -28	8:30232
83-754	NTIS, PC A02/MF A01; 1	DE83009972	MN -28	8:30233
83-755	NTIS, PC A02/MF A01; 1	DE83009973	MN -28	8:30169
83-756	NTIS, PC A02/MF A01	DE83009974	MN -28	8:30144
83-757	NTIS, PC A02/MF A01; 1	DE83009975	MN -28	8:30234
83-766	NTIS, PC A02/MF A01; 1	DE83009989	MN -28	8:30235
83-767	NTIS, PC A02/MF A01; 1	DE83009990	MN -28	8:30170
83-768	NTIS, PC A02/MF A01; 1	DE83009991	MN -28	8:30171
83-786	NTIS, PC A02/MF A01; 1	DE83010094	MN -34B	8:30614
83-787	NTIS, PC A02/MF A01; 1	DE83010090	MN -34B	8:30615
83-789	NTIS, PC A02/MF A01	DE83010082	MN -34B	8:30616
83-790	NTIS MF A01; 2	DE83010083	MN -34B	8:30617
83-796	NTIS, PC A02/MF A01; 1	DE83010086	MN -34C	8:30291
83-804	NTIS, PC A02/MF A01; 1	DE83010087	MN -38	8:30103
83-810	NTIS, PC A02/MF A01; 1	DE83010088	MN -37	8:30104
83-811	NTIS, PC A02/MF A01; 1	DE83010089	MN -28	8:30236
83-812	NTIS, PC A02/MF A01; 1	DE83009997	MN -34B	8:30618
83-817	NTIS, PC A02/MF A01; 1	DE83009998	MN -20b	8:30910
83-827	NTIS, PC A02/MF A01; 1	DE83010076	MN -34	8:30118
83-828	NTIS, PC A02/MF A01	DE83010000	MN -28	8:30237
83-841	NTIS, PC A02/MF A01; 1	DE83010079	MN -34C	8:30696
83-844	NTIS, PC A02/MF A01; 1	DE83010081	MN -28	8:30238
83-847	NTIS, PC A02/MF A01	DE83010095	MN -34A	8:30643
83-849	NTIS, PC A02/MF A01; 1	DE83010096	MN -28	8:30193
83-850	NTIS, PC A02/MF A01	DE83010097	MN -28	8:30194
83-851	NTIS, PC A02/MF A01; 1	DE83010098	MN -28	8:30145
83-872	NTIS, PC A02/MF A01; 1	DE83009884	MN -34A	8:30644
83-875	NTIS, PC A03/MF A01	DE83009886	MN -32	8:30095
83-885	NTIS, PC A02/MF A01	DE83009887	MN -59c	8:29804
83-892	NTIS, PC A02/MF A01	DE83009888	MN -34B	8:30619
83-918	NTIS, PC A02/MF A01	DE83009896	MN -37	8:30309
83-930	NTIS, PC A02/MF A01; 1	DE83009898	MN -20d	8:30911
83-931	NTIS, PC A02/MF A01	DE83009899	MN -20d	8:30912
83-952	NTIS, PC A02/MF A01; 1	DE83009904	MN -21	8:30913
83-953	NTIS, PC A02/MF A01	DE83009905	MN -38	8:30105
83-955	NTIS, PC A02/MF A01	DE83009907	MN -28	8:30239
83-956	NTIS, PC A02/MF A01; 1	DE83009908	MN -28	8:30240
83-964	NTIS, PC A02/MF A01; 1	DE83009909	MN -4	8:30041
83-968	NTIS, PC A02/MF A01; 1	DE83009910	MN -20d	8:30914
83-977	NTIS, PC A02/MF A01	DE83009912	MN -34B	8:30620
83973	NTIS, PC A02/MF A01	DE83009911	MN -20d	8:30915
LAFI-				
027	NTIS (US Sales Only), PC A02/MF A01	DE83701507	MN -34A	8:29954
043	NTIS (US Sales Only), PC A02/MF A01	DE83700206	MN -34A	8:29955
LAPP-TH-				
53	NTIS (US Sales Only), PC A02/MF A01	DE83700241	MN -34D	8:30697
LBL-				
11739	NTIS, PC A03/MF A01; 1	DE83011030	STD -95d	8:29805
14220	NTIS, PC A10/MF A01; 1	DE83011079	MN -61d	8:29289
14509	NTIS, PC A02/MF A01; 1	DE83009984	MN -95d	8:29806
14605	NTIS, PC A08/MF A01; 1	DE83011017	STD -66e	8:29445
15103	*See* NUREG/CR-3062	DE83010251	MN -70	8:29248
15715	NTIS, PC A04/MF A01	DE83009947	MN -48	8:30440
15716	NTIS, PC A04/MF A01	DE83011035	STD -94cb	8:29787
15752	NTIS, PC A08/MF A01; 1	DE83011082	MN -61a	8:29317
LCC-				
001/ 80	NTIS (US Sales Only), PC A02/MF A01	DE83701513	MN -38	8:29054
LIS-				
19	Available from Landesanstalt fuer Immissionsschutz des Landes Nordrhein-Westfalen, Essen (Germany, F.R.)			8:30335
LUIP-				
8205	NTIS (US Sales Only), PC A03/MF A01	DE83700201	MN -34A	8:30760
LUNFD6/NFFK-				
7018/ 1-31(1982)	*See* LUIP-8205	DE83700201	MN -34A	8:30760
LUNFD6/NFFR-				
1005/ 1-18(1982)	NTIS (US Sales Only), PC A05/MF A01	DE83700480	MN -41	8:29621
LYCEN-				
8161	NTIS (US Sales Only), PC A05/MF A01	DE83700207	MN -34A	8:29956

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8164	NTIS (US Sales Only), PC A05/MF A01	DE83700197	MN -34D	8:30717
MLM-				
3057(OP)	NTIS, PC A02/MF A01	DE83010021	MN -25	8:29987
MLR-				
1465	NTIS, PC A06/MF A01; 1	DE83009315	MN -38	8:30146
MPA-				
43	Available from Max-Planck-Institut fuer Physik und Astrophysik, Garching (Germany, F.R.)			8:30781
MPI-H-				
1982-V-20	Available from Fachinformationszentrum Energie, Physik, Mathematik, Karlsruhe (Germany, F.R.)			8:30731
MPI-PAE/Exp.El.-				
110	Available from Max-Planck-Institut fuer Physik und Astrophysik, Muenchen (Germany, F.R.)			8:30674
MPQ-				
64	Available from Max-Planck-Institut fuer Quantenoptik, Garching (Germany, F.R.)			8:30916
MTL/WDC-				
82TR520	NTIS, PC A10/MF A01; 1	DE83005093	STD -90d	8:28813
NASA/CR-				
165472	*See* DOE/NASA/0136-1	DE83010894	STD -90g	8:29780
165566	*See* DOE/NASA/0182-1	DE83009045	STD -60	8:29480
168110	*See* DOE/NASA/3303-4	DE83011212	STD -60	8:29481
NDRL-				
2454	*See* DOE/ET/00038-2454	DE83010648	MN -2	8:30076
NEANDC(US)-				
214/ L	*See* ANL-83-4	DE83008920	MN -79d	8:30746
NFL-				
31	NTIS (US Sales Only), PC A05/MF A01	DE83701505	MN -2	8:29757
NIIAR-				
12(465)	NTIS (US Sales Only), PC A02/MF A01	DE83700391	MN -80	8:29588
NIIEFA-P-B-				
0510	NTIS (US Sales Only), PC A03/MF A01	DE83700222	MN -20	8:30917
NMERDI-				
2-68-2131	NTIS, PC A04/MF A01; 1	DE83008656	MN -59a	8:29415
NP-				
3901799	NTIS (US Sales Only), PC A05/MF A01; 1	DE83901799	MN -4	8:30089
3901807	Alaska State Office, Public Room, 701 C Street, Box 13, Anchorage, Alaska 99513		MN -11	8:30398
NP-tr-				
3901609	NTIS (US Sales Only), PC A02/MF A01; 1	DE83901609	MN -95f	8:30166
3901613	NTIS (US Sales Only), PC A03/MF A01; 1	DE83901613	MN -95d	8:29815
3901618	NTIS (US Sales Only), PC A02/MF A01; 1	DE83901618	MN -90i	8:28970
3901620	NTIS (US Sales Only), PC A02/MF A01; 1	DE83901620	MN -95f	8:29814
3901801	NTIS (US Sales Only), PC A02/MF A01; 1	DE83901801	MN -92	8:29064
3901802	NTIS (US Sales Only), PC A02/MF A01	DE83901802	MN -92	8:29065
NSF-				
80-318	*See* PB-81-183873		MN -13	8:29758
NUREG-				
0580-Vol.12-No.3	NTIS, PC A02/MF A01; 1 - GPO	DE83901842	MN -80	8:29596
0827	NTIS, PC A21/MF A01 - GPO	DE83901962	MN -80	8:29679
0843-Suppl.3	NTIS, PC A07/MF A01 - GPO $6.50	DE83901633	MN -78	8:29597
0960-Vol.1	NTIS, PC A18/MF A01; 1 - GPO	DE83901600	MN -70	8:29133
0960-Vol.2	NTIS, PC A19/MF A01; 1 - GPO	DE83901642	MN -70	8:29134
0961	NTIS, PC A09/MF A01 - GPO $7.00	DE83901634	MN -80	8:29680
0979	NTIS, PC A20/MF A01 - GPO $11.00	DE83901662	MN -78	8:29681
NUREG/CP-				
0028-Vol.3	NTIS, PC A19/MF A01; 1 - GPO $11.00	DE83009128	MN -70B	8:29135
0030	NTIS, PC A15/MF A01; 1 - GPO $9.00	DE83001612	MN -70B	8:30589
0035	NTIS PC E10/MF A01 - GPO	DE83009326	MN -41	8:29682
NUREG/CR-				
2000-Vol.2-No.3	NTIS, PC A06/MF A01 - GPO	DE83010788	MN -80	8:29683
2044	NTIS, PC A09/MF A01; 1 - GPO	DE83011039	MN -80	8:29550
2331-Vol.2-No.3	NTIS, PC A08/MF A01; 1 - GPO	DE83010333	MN -78	8:29684
2422	NTIS, PC A06/MF A01 - GPO $5.50	DE83009489	MN -41	8:29255
2524	NTIS, PC A05/MF A01; 1 - GPO $5.00	DE83901632	MN -78	8:29565
2528	NTIS (US Sales Only), PC A10/MF A01; 1 - GPO $7.50		MN -78	8:29685
2530	NTIS, PC A10/MF A01; 1 - GPO $8.50	DE83010808	MN -78	8:29686
2774-Vol.4	NTIS, PC A03/MF A01 - GPO	DE83010607	MN -79p	8:29687
2809-Vol.4	NTIS, PC A03/MF A01	DE83010785	MN -79p	8:29688
2819	NTIS, PC A09/MF A01 - GPO $7.00	DE83901628	MN -15	8:29262
2853	NTIS, PC A08/MF A01; 1 - GPO $6.50	DE83901809	MN -78	8:29689
2913-Rev.4	NTIS, PC A13/MF A01; 1	DE83010239	MN -78	8:29690
2956	NTIS, PC A06/MF A01; - GPO $5.50	DE83010199	MN -78	8:29551
2972	NTIS, PC A23/MF A01; 1 - GPO	DE83901428	MN -78	8:29552
3027	NTIS, PC A04/MF A01 - GPO	DE83010379	MN -70A	8:29247
3062	NTIS, PC A17/MF A01; 1 - GPO $9.50	DE83010251	MN -70	8:29248
3084	NTIS, PC A07/MF A01; 1 - GPO $6.00	DE83901639	ND -70B	8:29155
3091-Vol.1	NTIS, PC A07/MF A01; 1 - GPO $6.00	DE83011205	MN -70	8:29156
3124	NTIS, PC A06/MF A01; 1 - GPO $6.00	DE83010802	MN -70	8:29249
3141	NTIS, PC A15/MF A01; 1 - GPO $9.00	DE83901640	MN -78	8:29691
3149	NTIS, PC A04/MF A01 - GPO $4.75	DE83010376	MN -12	8:29692
3157	NTIS, PC A10/MF A01 - GPO $7.50	DE83901841	MN -80	8:29693
3186	NTIS, PC A03/MF A01 - GPO $3.75	DE83010786	MN -70A	8:30317
3187	NTIS, PC A03/MF A01 - GPO	DE83010195	MN -70	8:29886

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3206	NTIS, PC A11/MF A01; 1 - GPO $7.50	DE83901845	MN -70	8:29157
3211	NTIS, PC A03/MF A01 - GPO $4.75	DE83901961	MN -11	8:30324
3220	NTIS, PC A04/MF A01; - GPO	DE83010286	MN -78	8:29553
NYSERDA-				
82-16	New York State Energy Research and Development Authority, Two Rockefeller Plaza, New York, NY 12223		MN -61a	8:29318
NZERDC-				
71	NTIS (US Sales Only), PC A05/MF A01; 1	DE83901425	MN -95f	8:29829
79	NTIS (US Sales Only), PC A03/MF A01; 1	DE83901605	MN -95f	8:29830
80	NTIS (US Sales Only), PC A07/MF A01; 1	DE83901604	MN -96	8:29817
82	NTIS (US Sales Only), PC A03/MF A01; 1	DE83901603	MN -61a	8:29319
83	NTIS (US Sales Only), PC A03/MF A01; 1	DE83901602	MN -61a	8:29320
NZERDC-P-				
73	NTIS, PC A03/MF A01; 1	DE83901659	MN -98G	8:29764
OEFZS-				
4079	NTIS (US Sales Only), PC A03/MF A01	DE83701524	MN -37	8:30292
ONWI-				
192	NTIS, PC A12/MF A01; 1	DE83010526	MN -70	8:29250
193	NTIS MF A01; 2	DE83010525	MN -70	8:29251
194	NTIS, PC A11/MF A01; 1	DE83010220	MN -70	8:29252
469	NTIS, PC A03/MF A01	DE83011112	MN -70	8:30374
ORAU-				
210	NTIS, PC A03/MF A01; 1	DE83010354	MN -88	8:28898
ORAU/IEA-				
83-4(M)	NTIS, PC A04/MF A01; 1	DE83010358	MN -97	8:29765
ORNL/CSD-				
114	NTIS, PC A02/MF A01	DE83011062	STD -32	8:30997
ORNL/CSD/TM-				
150	NTIS, PC A03/MF A01; 1	DE83010219	STD -71	8:29115
199	NTIS, PC A02/MF A01	DE83010405	MN -32	8:30918
ORNL/FEDC-				
82/ 2	NTIS, PC A20/MF A01; 1	DE83010328	STD -20	8:30919
ORNL/FMP-				
83/ 1	NTIS, PC A15/MF A01; 1	DE83010406	MN -90h	8:28814
ORNL/NSIC-				
194	*See* NUREG/CR-2044	DE83011039	MN -80	8:29550
200-Vol.2-No.3	*See* NUREG/CR-2000-Vol.2-No.3	DE83010788	MN -80	8:29683
ORNL/PPA-				
82/ 6	NTIS, PC A04/MF A01	DE83010404	MN -25	8:29755
83/ 3	NTIS, PC A03/MF A01	DE83010400	MN -95d	8:29807
ORNL/SUB-				
79-33200/ 12	NTIS, PC A03/MF A01; 1	DE83010911	MN -20f	8:30920
79-33200/ 13	NTIS, PC A03/MF A01	DE83010912	MN -20a	8:30921
ORNL/TM-				
8297	NTIS, PC A09/MF A01; 1	DE83010401	MN -80	8:29694
8347/ R1	NTIS, PC A04/MF A01; 1	DE83010978	STD -71	8:29116
8355	NTIS, PC A03/MF A01	DE83010407	MN -34D	8:30293
8397/ V4	*See* NUREG/CR-2809-Vol.4	DE83010785	MN -79p	8:29688
8530	NTIS, PC A03/MF A01	DE83010458	STD -20g	8:30859
8552	NTIS, PC A03/MF A01; 1	DE83010462	MN -90e	8:28874
8571	NTIS, PC A04/MF A01; 1	DE83010453	MN -95d	8:29808
8579/ S1	NTIS, PC A12/MF A01; 1	DE83010789	MN -70	8:29957
8583	NTIS, PC A02/MF A01	DE83010448	STD -77	8:29573
8588	NTIS, PC A05/MF A01; 1	DE83010452	MN -11	8:30358
8597	NTIS, PC A03/MF A01; 1	DE83010446	MN -41	8:30366
8613	NTIS, PC A03/MF A01	DE83010449	STD -86	8:29109
8616	NTIS, PC A03/MF A01	DE83010447	STD -20a	8:30922
8628	NTIS, PC A03/MF A01; 1	DE83010386	MN -61b	8:29321
8693	NTIS, PC A02/MF A01	DE83010410	MN -34C	8:30645
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831	NTIS, PC A06/MF A01	DE83011013	STD -70A	8:29256
832	NTIS, PC A11/MF A01	DE83011018	STD -70A	8:29257
OTA-E-				
192	GPO		MN -95f	8:29854
P-				
82/ 13	TNO, PO Box 217, Delft, Netherlands			8:28868
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A 6-258,351		DE83010464	MN -80	8:29614
A 6-266,247		DE83010465	MN -38	8:30116
A 6-274,120		DE83010466	MN -38	8:30151
A 6-279,391		DE83010467	MN -88	8:28899
A 6-298,448		DE83010468	MN -41	8:30300
A 6-340,919				8:29832
A 6-374,655		DE83010469	MN -34	8:30122
A 6-374,675		DE83010470	MN -63	8:29335
A 6-374,847		DE83010471	MN -20	8:30954
A 6-375,232		DE83010472	MN -25	8:29173
A 6-375,518		DE83010473	MN -37	8:30149
A 6-375,519		DE83010474	MN -94a	8:29723
A 6-375,523		DE83010475	MN -38	8:30112
A 6-375,525		DE83010476	MN -25	8:29966
A 6-375,529		DE83010477	MN -38	8:30150
A 6-375,645			MN -25	8:30136
A 6-376,088		DE83010479	MN -38	8:29334
A 6-377,773		DE83010480	MN -2	8:30299
A 6-377,898		DE83010481	MN -23	8:29993
A 6-379,418		DE83010482	MN -95d	8:29812
A 6-379,797		DE83010483	MN -37	8:30121
A 6-379,798		DE83010484	MN -37	8:30165
A 6-379,799		DE83010485	MN -25	8:29946
A 6-379,800		DE83010486	MN -70	8:29172
A 6-379,801		DE83010487	MN -70	8:30017
A 6-381,277		DE83010488	MN -25	8:29896
A 6-382,061		DE83010489	MN -95d	8:29811
A 6-382,997		DE83010490	MN -38	8:30604
A 6-382,998		DE83010491	MN -94c	8:29722
A 6-383,048		DE83010492	MN -38	8:30111
A 6-383,880		DE83010493	MN -70	8:29166
A 6-384,306		DE83010494	MN -79k	8:29590
A 6-384,307		DE83010495	MN -38	8:30109
A 6-385,202		DE83010496	MN -94cc	8:29721
A 6-385,206		DE83010497	MN -91	8:29070
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A 6-386,370		DE83010499	MN -37	8:30148
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A 6-387,060		DE83010502	MN -37	8:30120
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A 6-387,115		DE83010506	MN -63b	8:29333
A 6-388,872		DE83010507	MN -61a	8:29332
A 6-388,873		DE83010508	MN -20a	8:30949
A 6-388,874			MN -95d	8:29810
A 6-388,875		DE83010510	MN -95d	8:29809
A 6-389,343		DE83011038	MN -93	8:29858
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HT	Haiti
HU	Hungary
HV	Upper Volta
IA	Inter-American Nuclear Energy Commission
IB	International Bank for Reconstruction and Development
ID	Indonesia
IE	Ireland
IG	Inter-Governmental Maritime Consultative Organization
II	International Commission on Radiation Units and Measurements
IL	Israel

IN India
IO International Labor Organization
IP International Union of Pure and Applied Physics
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TD Chad
TG Togo
TH Thailand
TN Tunisia
TO Tonga
TR Turkey
TT Trinidad and Tobago
TW Taiwan
TZ United Republic of Tanzania

UA Ukrainian Soviet Socialist Republic (Ukrainian SSR)
UE United Nations Educational, Scientific and Cultural Organization
UF United Nations Children's Fund
UG Uganda
UI United Nations Industrial Development Organization
US United States of America (USA)
UY Uruguay

VA Holy See
VD Democratic Republic of Viet-Nam
VE Venezuela
VS Republic of Viet-Nam

WM World Meteorological Organization
WS Western Samoa

XA International Atomic Energy Agency (IAEA)
XC European Organization for Nuclear Research (CERN)
XE Commission of the European Communities (CEC)
XF Food and Agriculture Organization of the United Nations (FAO)
XJ Joint Institute for Nuclear Research (JINR)
XM Council for Mutual Economic Assistance (CMEA)
XN Nuclear Energy Agency of the OECD (NEA)
XO Organization of African Unity (OAU)
XR International Commission on Radiological Protection (ICRP)
XS International Organization for Standardization (ISO)
XU United Nations (UN)
XW World Health Organization (WHO)
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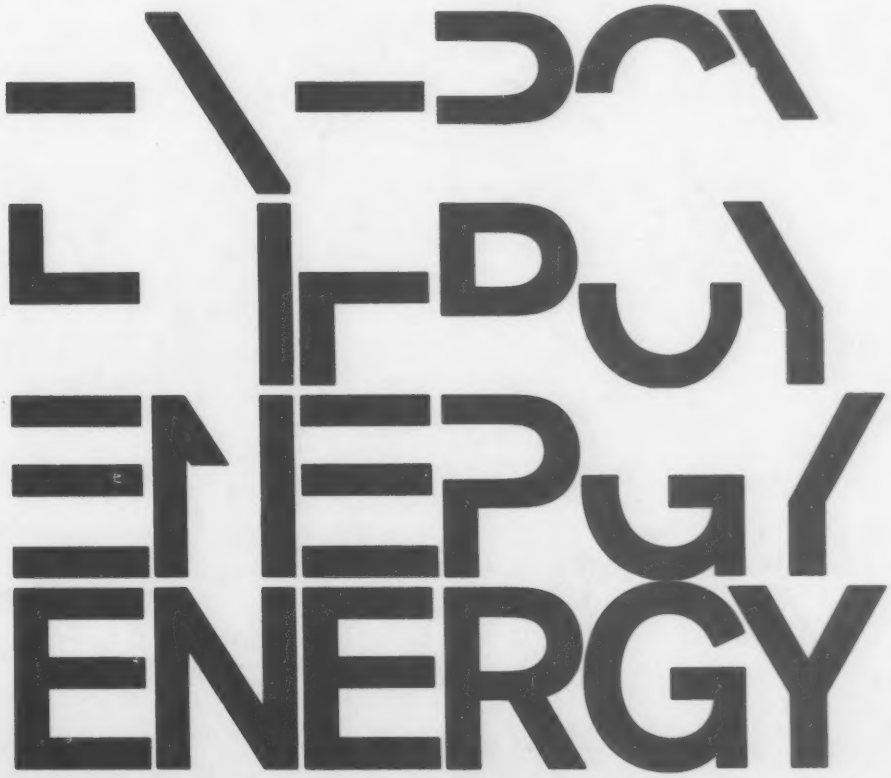

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NORTH CAROLINA
Raleigh, North Carolina State University

OHIO
Cincinnati, University of Cincinnati
Cleveland, Cleveland Public Library

OKLAHOMA
Norman, University of Oklahoma

PUERTO RICO
San Juan, University of Puerto Rico

SOUTH CAROLINA
Columbia, University of South Carolina

TEXAS
Austin, University of Texas
College Station, Texas A & M University
Houston, Rice University

UTAH
Salt Lake City, University of Utah

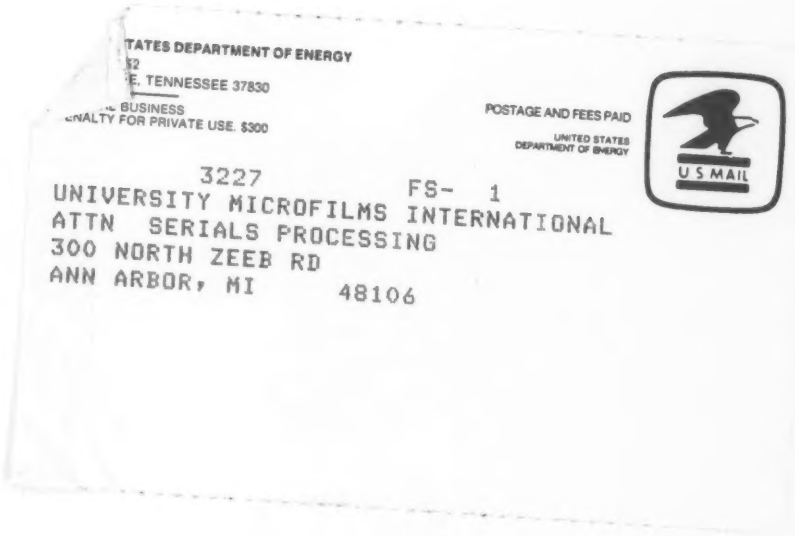
WASHINGTON
Pullman, Washington State University
Seattle, University of Washington

WISCONSIN
Madison, University of Wisconsin

International

EUROPEAN ATOMIC ENERGY COMMUNITY (EURATOM)
Brussels, Belgium
Ispra, Varese, Italy, Cetis Library

INTERNATIONAL ATOMIC ENERGY AGENCY (IAEA)
Vienna, Austria

OECD NUCLEAR ENERGY AGENCY (NEA)
British Library Lending Division
Boston Spa, Wetherby, Yorkshire, England

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